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For publication early in 1921.

MEDICAL AND SURGICAL NOTES FOR MEDICAL GYMNASTS

By

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Translated by

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MASSAGE

AND

MEDICAL GYMNASTICS

BY

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WITH 182 ILLUSTRATIONS

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TO

MY VALUED FRIEND

PROFESSOR JOHN BERG

THIS WORK IS DEDICATED,

AS A

TRIBUTE OF ESTEEM AND AFFECTION,

BY

EMIL A. G. KLEEN.

FOREWORD.

Massage and Physical Exercises have formed a branch of medical and surgical treatment from time immemorial and in all countries, a fact demonstrated by Dr. Kleen in his historical introduction; and Dr. Kleen's work is a classic upon the subject which deserves the widest possible circulation throughout the world. Its translation into English may therefore be welcomed as a very real step in the diffusion of scientific knowledge upon these methods of treatment. Naturally the author's views will receive criticism when they come to be read by English-speaking people. Swedish methods of massage and gymnastics are not universally accepted as gospel. Sound and considered criticism is healthy, and Dr. Kleen would himself be the last to raise objection to it. But the great scientific work that has been done by the Swedish schools during the last hundred years has undoubtedly done more to place this branch of treatment upon an acknowledged footing than has that of any other group of workers.

The necessity for the general study of physical methods of treatment has been demonstrated afresh in the work of war surgery. Too often have we seen the wonderful work done for the wounded by surgeons at military hospitals robbed of its final success by failure to secure the eventual functional utility of the damaged member by the use of appropriate physical methods. And of all the methods of physiotherapy the use of natural movements introduced in scientifically conducted physical exercises must always remain the foremost. The treatment of these late results of wounds and injuries has aroused an interest in orthopædic surgery that is unprecedented. Orthopædic surgery includes something much more than the simple prevention and correction of deformities. The orthopædic surgeon should think in terms of "Function," and his endeavour should be to restore the affected part to its full normal functional activity, or if this is impossible to secure the very best possible return of functional utility. In this final restoration physical exercise must necessarily take a leading part.

There is without question a large field for a class of worker trained in massage, physical exercises, and other methods of physical treatment, with a limited knowledge of anatomy, physiology, and

pathology. These masseurs and masseuses become specially skilled in physical treatment, but their necessary lack of knowledge of general medicine and surgery and of other methods of treatment must limit their outlook to some extent. How frequently must the masseur inquire of the surgeon whether there is any pathological obstruction to a particular movement, or whether there is any pathological change taking place that contra-indicates the forcing of movement. So that in the work of these therapeutists, skilled, but only in one particular branch of treatment, adequate and intelligent direction by the physician or surgeon is essential. Unfortunately the latter too often knows so little of the methods and effects of massage, of the range and mechanism of movements, that he is unable even to guide the masseur by informing him of the end that he desires to attain, much less to instruct him in the means to be employed. Too often the patient is handed over with the general instruction that he is to have "Massage," and any inquiry as to the object of treatment or the actual methods to be used is met by an evasive reply. Two things are necessary: first, the education of the medical profession in the elements of rational physical treatment in all its branches, and second, the inculcation in the masseur of the knowledge that he is a skilled worker in a particular branch of therapeutics and that he is not omniscient in all branches of medicine and surgery.

Dr. Kleen has much criticism to offer of the methods of training adopted in the official schools of massage and physical exercises in Sweden. This will amply repay study in this country, particularly at the present time, when the training and status of the masseur and of the instructor in educational and remedial gymnastics is much under discussion. In the Central Institute in Stockholm the training of instructors in military and educational gymnastics is combined with a school of physiotherapy. One result has been that the trained instructors have too often abandoned the educational side of their work to take up remedial work entirely, because they find that the latter offers a better pecuniary reward. In this way there has been a real loss to physical education. But perhaps the more serious aspect has been the setting up of a class of gymnasts, possessed of an official diploma, who consider themselves qualified to carry out treatment by massage and remedial gymnastics without medical consultation or supervision. And it is evident that in Sweden, as in this country, the average medical man is so ignorant of physical methods of treatment that he is unable to give adequate directions to the masseur. The knowledge that this is so has led to a request by the Carolinska Institute for the inclusion of a course in remedial gymnastics in the curriculum

for medical students. It is perhaps too much to expect that a similar view will be taken by the medical educational authorities in this country without at least a preliminary campaign; but it must be evident that a knowledge of the principles of educational as well as of remedial gymnastics by the younger generation of medical men of the country would be an enormous asset to the public health and to the physical well-being of the nation.

R. C. ELMSLIE.

TRANSLATOR'S PREFACE.

FIRST EDITION.

THE translation of Dr. Kleen's book on "Massage and Medical Gymnastics" has been a gigantic task, since it has been carried out in scanty leisure time. I was impelled to undertake it by the knowledge that there was no book in English offering such a store of information and research on the uses to which this treatment can be put in Medical, Surgical, and Gynæcological cases, as well as in certain diseases of the Eye, Throat, and Ear.

The earlier part of the book and Dr. Arvedson's chapter will, I trust, be useful to students of Massage and Gymnastics. I hope the book as a whole, and especially the later chapters, may induce members of the medical profession to take more interest in the application of a widely used method of treatment which they have so far left too much in the hands of Swedish Medical Gymnasts. If the book fulfils these aims I shall feel that my labour has not been in vain.

MINA L. DOBBIE.

SECOND EDITION.

THE reception given to the First English Edition of Kleen's "Massage and Medical Gynmastics" has shown that an increasing interest is being taken in the subject. It has therefore become necessary to produce a second edition, and this has been carefully revised throughout.

MINA L. DOBBIE.

PREFACE.

I AM issuing now a thoroughly revised and improved Swedish edition of my text-book, which has been the chief guide to doctors, medical students, masseurs, and medical gymnasts in Scandinavia, for more than a quarter of a century in massage, and of late years also in medical gymnastics.

Every doctor who himself practises massage, and employs it to its full therapeutic extent, has now abundant opportunity of gaining experience in it. I have not felt that I needed any assistance for my description of it beyond the literature on the subject. Neither have I seen any reason for making any material alteration in what I wrote over twenty years ago. In this edition I have merely introduced the results of the researches made during the last few years by various doctors and investigators concerning massage.

On the other hand, a doctor who is not a specialist in medical gymnastics seldom becomes very familiar with any special gymnastic system. I have certainly obtained for myself a fairly wide knowledge of the physiological and therapeutic effects of movements. But my experience is chiefly medical, and I have not made a special study of medical gymnastics or orthopædics. Therefore, since I wished to make my text-book "Kleen's Massage," of which 3,000 copies had already been sold, as comprehensive as possible in regard to medical gymnastics, I invited Dr. J. Arvedson, Gymnastic Director, to write a chapter on Ling's Medical Gymnastics, and Dr. E. Zander to write one on Zander's Medical Gymnastics. Finally I requested Dr. Patrik Haglund to write a chapter on the Use of Medical Gymnastics and Massage in Orthopædics. They willingly granted my request, and I obtained the rights of publication for their respective articles, which are included here in the same form as in the last two thousand copies of this work (Chap. IX. —XI.). For the remainder of the book I alone am responsible.

Work in medical gymnastics carried on by others in my own clinic in Stockholm led me to make a closer study of Ling's system. This made me aware of certain defects in my former account of medical gymnastics, and led me to a thorough revision of the subject.

Since the book is read by many who have had no medical education, I have included numerous notes on physiology.

Many of the illustrations have been replaced by better ones.

It is to be hoped that the book may thus maintain the leading position it has hitherto held in the literature of the subject.

EMIL A. KLEEN,
Doctor of Philosophy and Medicine.

Sjövik,
Saltsjöbaden.

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The History and Present Position of Massage and Gymnastics.

INTRODUCTION.

From time immemorial people of all races have had some idea of the hygienic and therapeutic importance of physical exercise. Gymnastics in some form has therefore always been used, sometimes as exercise in the open air, sometimes, and especially in the ancient civilisations, as a more or less developed system of positions and movements.

It has also been understood from time immemorial that many local and general diseased conditions may be cured or relieved by mechanical treatment of the soft parts in the form of movable pressure, by stroking, rubbing, kneading, as well as by clapping and beating. Massage, as well as gymnastics, is a very ancient form of treatment, so ancient that one may consider its history to be as old as that of mankind, and its beginning prehistoric.

Gymnastics and massage, treatment by exercise of the motor apparatus, and treatment by manipulation of the soft parts have so much in common that their history may well be given together. Both methods of treatment are practised by the same craftsmen, and have so much in common that unintelligent people who have used them both for years are often unable to draw a distinction between them which can be understood by people of ordinary intelligence. For the most part, nowadays, in all civilised countries a distinction has been made with more or less clearness between massage and gymnastics.

It has been the fashion among historical writers on the subject to assert that the earliest writings on massage and gymnastics are found in Kong-fu's Chinese "White Books," of great but uncertain antiquity, as well as in the earlier of the Indian Vedas, called the "Ayur-Veda," written by Susruta, the pupil of Dhavantare, who is said to have lived in the eighth century. According to Nebel, no clear expositions of medical gymnastics nor *evidence* of Chinese massage of remote antiquity are found in Kong-fu's work, and Dally's complaint against the Swedish gymnasts of having plagiarised from their Chinese colleagues is absurd. Neither has Professor Pagel of Berlin found anything on these subjects in the "Ayur-Veda," but this does not throw doubt on the fact that mechano-therapy, especially in the form of massage, is many years old in India, and probably also in China.*

* See, concerning ancient Asiatic mechano-therapy, Père Amyot's "Mémoire concernant les Chinois" (1776), Lepage's "Recherches Historiques sur la Médecine des Chinois" (1813), Huc's "L'Empire Chinois" (1831), Dr. Wise's "Commentary on the Hindoo System of Medicine," Calcutta, 1845, and H. Nebel's articles in Langenbeck's "Arkiv.," Bd. 44, and in "Deutsche Med. Wochenschrift, 1887."

The ancient Egyptians probably knew massage and medical gymnastics in some form.*

From the ancient Greeks we have interesting information on the subject. Gymnasia with their attendants (the chief "physical treatment" quacks of ancient Greece—its "gymnastic directors") were the places for such treatment. Herodikos, or as he is also called Prodikos of Selymbria, who appeared shortly before Hippocrates, was such a gymnastic director of the cocksure uncritical type, and treated even febrile diseases with a form of "terrain-cure."

Hippocrates (460—377 B.C.) mentions the utility of friction after sprains and reduced dislocations, recommends abdominal kneading for constipation, knew of chest-clapping, "terrain-cures," etc.

Among the many benefits of culture which Greece imparted to the conquered Romans were some in the department of medicine, and mechano-therapy flourished in Rome, chiefly owing to Greek influence. Some of Rome's most famous doctors were Greeks, and among their names is that of Asclepiades, who practised shortly before the Christian era, and who employed massage and gymnastics freely, and according to Pagel seems to have been the father of mechano-therapy in the Roman world. We learn also from Roman literature † in the dawn of our own time that both gymnastics and massage were highly valued by the profession and the public. The fact that Galen (A.D. 131—201), the most eminent doctor of the Roman Empire, gave it great attention had an important influence on mechano-therapy. His influence, as we know, extended several centuries beyond his own time, and it is partly due to him that this method of treatment did not entirely fall out of use in the Middle Ages. Thessalus of Tralles, Aretæus of Cappadocia, Rufus of Ephesus, bear witness that both gymnastics and massage had a certain time of prosperity under the Roman Empire. It is very interesting to find that the last-named shows the scientific spirit by mentioning kidney disease as a contra-indication to gymnastics. Obesity, gout, paralysis and many other diseases were treated by mechano-therapy. About A.D. 250 Flavius Philostrates produced his great work on this method of treatment. Alexander of Tralles and Paul of Ægina also belong to this period. The latter specially mentions mountain climbing. In the fifth century Oribasius wrote his well-known work, which is our chief source of knowledge of ancient mechano-therapy; in the sixth century we find from a work on the treatment of obesity that gymnastics was still alive; in the seventh century Aëtius of Amida wrote of active and passive movements, resistance movements (see later concerning Ling), and friction.

The further we follow the literature of the Middle Ages, the fewer signs of life do we find in mechano-therapy, and it seems to share the fate of all knowledge in not being able to advance without at the same time losing much of what has already been won. It is obvious that the

* Prosper Alpinus: "De re Medica Egyptorum, 1591." Regarding ancient European mechano-therapy, see C. Keyser's Latin translation of "Flavius Philostrates," Heidelberg, 1840; "Œuvres d'Oribase, Bussemaker and Daremberg," Paris, 1851; Pagel, "Einführung in d. Geschichte d. Medizin," Berlin, 1898.

† "De Medicina"—the work of Aulus Cornelius Celsus, in German, by B. Ritter, Stuttgart, 1840.

seeds sown by previous generations would find the conditions of life unfavourable in an age which more and more turned away from experience towards pure speculation, and finally took refuge in complete mysticism. It is true that the Arabs, whose dominion over medicine (from the ninth century) extended over several centuries, followed for the most part the teaching of Galen, and could not therefore quite neglect a treatment so highly valued by him. Avicenna, in particular (born A.D. 980), was interested in physical treatment, especially gymnastics. The monks, too, who were the chief practitioners of medicine in this period, were, as doctors, followers of Galen. But the Arabs turned in preference to pharmacology for their therapeutics, and the monks found prayers and exorcising easier than massage and gymnastics.

From the thirteenth century we have two rather important works, one by Johan de St. Amand of Tournay, the other by Petrus of Apono, who discussed the hygienic and therapeutic value of physical exercise.

In the fourteenth century anatomy began to free itself by degrees from the traditions of Galen, and reached during this and the two following centuries a comparatively secure position. One of the conditions for the development of mechano-therapy was thus fulfilled, and it was not long before various signs of new life were apparent in this field. The great Ambrose Paré (1517—1590) warmly upheld mechanical treatment, and tried to base it on anatomical and physiological grounds, a fact of greater importance than the favour shown at the same time towards gymnastics by the brilliant charlatan Paracelsus. We find, moreover, in the sixteenth century many scientists and doctors who may be considered worthy of mention in a historical survey of this kind: Leonard Fuchs in Germany, Timothy Bright in England, Champier du Choul and Faber de Saint Jory in France, Antonius Gazi, Prosper Alpinus, Andreas Lacuna, Hieronymus Mercurialis, and Fabricius of Aquapendente in Italy. The last-named, in common with several other people, has been regarded by many as the originator of massage. The best-known work of this time is "De Re Gymnastica Velerum," by the renowned Hieronymus Mercurialis (1569).

Here, too, we find traces of the mighty genius and versatile activity of Lord Bacon of Verulam (1561—1626), and it is very interesting to see his wonderful acuteness asserting itself even on this subject. From one of his countrymen, Murrell, I quote Lord Bacon's opinion on massage: "Frictions make the parts more fleshy and full, as we see both in men and the currying of horses. The cause is for that they draw greater quantity of spirits and blood to the parts, and again because they draw the ailments more forcibly from within, and again because they relax the pores and so make better passage for the spirits, blood and ailment; lastly, because they dissipate and digest any inutile and excrementitious moisture, which lieth in the flesh, all which helps assimilation." It is easy to translate these words, written about 300 years ago, and almost as much an expression of the dim and erroneous ideas of the time as of his own natural clear-sightedness, into the scientific language of our time, and to find in them at least surmises of the power of massage to counteract atrophy, to hasten the circulation, to promote the absorption of pathological tissue elements, and to improve general nutrition.

The literature of the seventeenth century, especially of its latter half, shows many scattered signs of the use of physical treatment, although not to the extent one might have expected, judging from other phenomena of this time. The mechanical view of physiological processes began to assert itself more and more, and the " gymnasts " of this time rendered considerable service here as well as in the advance of anatomy. But their therapy was remarkably little affected by their theories, and neither gymnastics nor massage can be said to have gained very much from their work. Borelli (1608—1679) meanwhile wrote his famous book, " De motu animalium," a bulky work which came out in 1670, and in which the mechanics of movement and of respiration were fully set forth. This work must have had some influence on the development of rational gymnastics. Another Italian, Baglivi, was much addicted to treatment by movement and friction, " which give tone and suppleness to the limbs and tissues." In England, according to Tissot, massage made marked progress during the seventeenth century, and evidence of this is found in literature. Sydenham lays stress upon the value of exercise in constipation, gout, etc. In 1666 a remarkable work was published by Dr. Henry Stubbe, a doctor practising at Stratford-on-Avon, with the illuminating title " An account of several marvailous cures performed by the stroaking of the hands of Mr. Valentine Greatarick." It is worth noting that Sir William Temple (the father of the Triple Alliance), who, whenever he had a presentiment of clouds in the political heavens or otherwise found the troubles of a statesman's life too heavy, was in the habit of retiring to " his little nest at Sheen " to divide his time between gardening and literary work,—this cautious gentleman I say, wrote an essay on " Health and Long Life," as well as much else, in which the value of massage is considered and in which it is specially recommended for the treatment of joint affections. Guyon wrote in 1615 his " Miroir de la beauté," in which he calls massage to the service of beauty (for which it can seldom be of much use). J. H. Meibom produced in 1639 a work " Von der Nützlichkeit der Geisselhiebe in medizinischer und physischer Beziehung." Another curiosity from this time is the well-known " Flagellum-Salutis " (1698), in which Paullini praises massage for many things, but especially for pleasure. Paullini was a poet, that is to say, and it is to be hoped that the services he rendered to poetry were greater than those to mechano-therapy. He takes up an extremely naïve standpoint, and is one of the first in the wearisome list of uncritical dreamers who regard massage (with him equivalent to *tapôtement*) as being able to cure all possible complaints, not excepting syphilis.

Between the seventeenth and eighteenth centuries we come across a great German name, Friedrich Hoffmann (1690—1742, " Dissertationes physicomedicæ," Halle, 1708). Hoffmann pronounces gymnastics to be the best form of remedy, owing to its influence on the circulation, appetite and general condition, etc., and also discusses massage, following the example of Hippocrates, Celsus and Galen. There is no doubt that he contributed in a marked degree to the development of mechano-therapy in Germany, England and France during the eighteenth century. In Germany, in the earlier part of the century, we find the smaller works

of Stahl, Wedel, Alberti and Buchner, in 1748 Boerner's "Dissertatio de arte Gymnastica" and Gehrike's "De Gymnasticæ medicæ veteris inventoribus" were printed in Helmstadt, and in 1749 Quellmatz's "Programma de frictione abdominis" in Leipzig. In England we find a work "Medicina Gymnastica, or Treatise Concerning the Power of Exercises"; in Scotland (1788), a treatise "De Exercitatione," by Sherlock. In France mechano-therapy had a period of real prosperity. Andry, in 1741, printed in Paris his remarkable "Orthopædics"; Winslow, also a well-known Parisian doctor, employed mechanical treatment for deformities (Dally); Rousseau recommended brisk exercise and gave a strong impulse to educational gymnastics; the renowned Tissot (a Swiss) wrote his "Gymnastique medico-chirurgicale" (Paris, 1780), and therein discussed massage in detail ("wet" or "dry," with weak, medium, or strong friction). Dr. Tronchin of Paris, a man in high general esteem, used gymnastics and massage assiduously in his enormous practice. These were both in fashion at that time in the French capital.

Towards the end of the eighteenth century there was a great development of gymnastic activity in Germany, but practically only in educational gymnastics. From 1770, it may be reckoned, many became instrumental in spreading it in schools, till its use became general all over Germany. I remember in this connection the well-known names of Frank, Basedow, Salzmann, Guthsmuths, Viehy, Pestalozzi, Jahn, Eiselen, Massmann, Lorinser, Spiess, and others whose work belongs partly to our own century. In literature Guthsmuths is the best known of the German authors, and one comes across his work, "Die Gymnastik der Jugend" (Schnepfenthal, 1793), here and there in book collections. One notices markedly the influence of the ancient writers and also of Friedrich Hoffmann. Guthsmuths speaks in detail and intelligently of some of the effects of gymnastics, emphasises the necessity for developing the different muscle groups harmoniously, and mentions active and passive movements. In the end of his work he shows the ease with which one may, with the help of an anatomical atlas and a skilful doctor, work out a scientific gymnastic system, and gives the outline of such a system. Although the real value of massage was recognised by many long before this time, it seems to have lain outside Guthsmuths' thought and experience.

It may be appropriate to pause here to remind ourselves of the great activity of practical and theoretical medico-mechanics, both in regard to gymnastics and massage, towards the end of the eighteenth century, and especially to remember that when Tissot wrote his famous work in 1780 the so-called Swedish medical gymnastics did not exist, and that Per Henrik Ling, who later rendered his fatherland and all mankind such great (though uncritically and ignorantly estimated) service in this direction, was then only four years old.

Meanwhile we must remember that *massage*, in the end of the eighteenth and beginning of the nineteenth centuries, was nowhere deeply rooted either in England or on the continent of Europe. In France especially, although it was practised by several doctors prominently represented in literature, it seems, after a rise of rather short duration in the end of the eighteenth century, to have sunk into discredit or been

forgotten in the beginning of the nineteenth. For example, Londe (" Gymnastique Médicale," Paris, 1820, pp. 249—255) speaks of " frictions et onctions, le massage et le massement," disapproves of "onctions," and mentions frictions as " useful for people who take no exercise, also in some diseases," of which, however, not a word is said. They are especially good for people " who live in northern, marshy countries, and for those weakly children with fair hair, blue eyes and large heavy abdomen, who are so sluggish physically and intellectually." He further thinks he has heard of massage in Tahiti, considers it tonic, but accuses it of encouraging sensual sensations. This is amusing, but it is still more amusing that on this account Hünerfauth, in his " Handbuch der Massage," gives as his verdict that Londe has written of massage that it is " ziemlich erschöpfend."

Swedish traditions on mechano-therapy begin with Per Henrik Ling (1776—1839). Ling made his appearance as early as 1805 as a gymnastic and fencing teacher in Lund ; in 1813 he founded the " Central Institute of Gymnastics " in Stockholm and remained a teacher there until his death. His chief work, " On the General Principles of Gymnastics," came out first in 1840 after his death. Since he is much talked of but really very little known, and since, as a fellow-countryman, he specially interests the readers of the Swedish edition of this work, I will discuss somewhat in detail the significance of his work in regard to mechano-therapy.

The Ling system of gymnastics, in contrast to the German system, was chiefly therapeutic (" medical gymnastics "), although Ling to a great extent looked after the interests of educational gymnastics. He arranged a great many movements, which, according to ancient custom, he divided into passive, active and duplicated. It is less known, but of more interest to us and a greater service on Ling's part, that he was familiar with massage, the manipulations of which (" friction, hacking, pinching, squeezing, kneading," *l. c.*, p. 581) he classes as passive gymnastic movements. Massage forms a very important part of the Ling system of " medical gymnastics " and is used in many forms. Ling mentions (p. 530) neck massage, which he recommends for headache and giddiness, was familiar with " abdominal kneading," and made use of both local and general massage with almost the same technique as is now used by Swedish doctors and by all the so-called Mezger's school. Leaving out the noisy advertising and " puffing " of Swedish gymnastics by Ling's followers, it was chiefly massage which gained for this form of therapy the prestige it has won. Moreover, among the workers trained by the Central and other institutes, massage forms a more important and essential part of their work, both for themselves and their patients, than gymnastics. It is worth noting that Ling himself included massage manipulations among passive gymnastic movements, and that the Swedish gymnasts, partly in reverence for their idol, partly from a practical motive, have done their utmost to eradicate the term " massage " and to represent the use of movable pressure on the soft parts as a special part of gymnastics.

By his own practical work and also by his own creation, the " Central Institute of Gymnastics " (notwithstanding its later vagaries), Ling

exercised a great influence on the position of massage and medical gymnastics in and beyond Sweden.

At the same time, he has performed a very important life work by contributing in a high degree to the development of Swedish sport. This he did by educational gymnastics, and by different exercises (" the horse," " the boom," " the ropes," fencing).

And lastly I would lay stress on a very great service Ling rendered. He himself clearly saw and often expressed his opinion (as I and others have heard from conversation with the well-known Major Thure Brandt) on the necessity of his treatment being under the control of doctors. In contrast to many of his followers, he was an unpretentious worker at mechano-therapy, devoted to his life's work and entirely opposed to advertisement, " business," and the seeking of a monopoly.

We have, therefore, every right, on account of Ling's character and of his important life work, apart from his very good work as a poet, to include him in the number of our really great men. His worth is not diminished either by the fact that his work has been partly spoiled by others, or that he himself has been indiscriminately praised, widely advertised, and painted in false colours.

It is not Ling's fault that his picture has been made to serve as a sign-board for that market where Swedish gymnastics has been offered for sale with drums and trumpets, with charlatan clamour and brag, and with crude ignorance and *naïveté*. Unfortunately, Ling has been represented not only as the devoted, honourable, modest, industrious, and talented worker in the service of mankind which he really was, but also, what he certainly was not, as an epoch-making discoverer of a method of treatment which only his own school is able to carry out. We have already seen that both massage and gymnastics, long before the beginning of the nineteenth century, were so generally used and in all essentials so much developed that no very great " originality," nor the services of a " discoverer," were necessary to bring this simple method of treatment into use. All that Ling used had for long been in use, with the exception of some special movements, which, as Guthsmuths had already pointed out, were easy to arrange. It is certain from Ling's own writings that he knew the ancient European mechano-therapy. It would be an absurdity to assume that he did not know the French " medico-chirurgical gymnastics," in which massage was included or German gymnastics, which began to flourish during his youth and which, in spite of his criticism of it, had a great influence on his own work. For those who will not claim for their own nation more than justly belongs to it, it is not too far-fetched to consider that Swedish medical gymnastics is the offspring of German and French parents, although the child certainly attained stronger vitality than either of its parents.

Nor can it be denied that Ling's ignorance of medicine and the subjects connected with it, along with a certain want of clearness and tendency to mysticism, had a detrimental influence on his work. He was able with his conscientiousness, enthusiasm and energy to obtain good therapeutic results and to spread his treatment far and wide. But he was not able to establish it on a scientific basis and to develop it. To make clear the physiological and therapeutic effects of mechanical

treatment, to set forth and limit its indications, was not within Ling's power, and his own representations of these things were extremely fantastic. In his work he tried to replace knowledge of the facts relating to it by purely speculative subtleties, none of which have any independent merit. The writings of this man, in many ways so eminent, do not therefore stand ahead of his time, but even contrast unfavourably with those of many earlier writers.*

Some short extracts from Ling's work, " On the General Principles of Gymnastics," should give the reader a good idea of his standpoint. The book is divided into six parts which treat of (1) the laws of the human organism ; (2, 3, 4, 5) the principles of educational, military, medical and æsthetic gymnastics ; and (6) gymnastic apparatus. The first division contains what Ling certainly considered a complete philosophic system, in which three primitive forms of vital force play the chief part. These are (p. 444) " the dynamic, in which life, as if expressing its independent existence, tries to free itself from matter, chemical and mechanical, by which life in combination with matter manifests itself ; yet it seems that life is more evident in chemical power, matter in mechanical, so that both of these may be considered forms of it under different conditions." The dynamic form corresponds in the organism to the nervous system, the chemical to the circulatory, the mechanical to the muscular system. Mutual harmony between these three " agents " constitutes health. When the harmony is disturbed illness arises in such a way that " when the dynamic form is the chief agent, illness arises in the mechanical form ; when the mechanical is most active, the illness takes the chemical guise ; and when the chemical is the chief agent, the illness shows itself in dynamic power " (p. 523). Ling did not here feel himself to be on certain ground, but remarks that when so many learned men have made mistakes in this region his opinion, too, must be carefully revised " where necessary."

Ling reasons widely about the fundamental forms of life and their connection with diseases and their symptoms. " A disease, as cause, generally belongs to, and also manifests its sign in, one fundamental form, although the latter may not be the same as the former ; we call this a one-symptomed disease. But if the cause of disease belongs to one of the fundamentmal forms, and its signs are manifested in the two other, or even three other fundamental forms, we call it many-symptomed " (pp. 519—520). Concerning these distressing many-symptomed diseases

* Ling had a manly, independent and warm-hearted personality, and won in a high degree the affection and esteem of his pupils. These feelings have been inherited by the present generation of Swedish gymnasts, who often regard Ling with an admiration which excludes all criticism. It is both touching and amusing to see with what reverence these gentlemen receive the greatest oddities that flowed from Ling's pen. This reverence is only increased by the fact that they, pardonably enough, do not in the least understand what their idol means, and they remind one very strongly of Peer Gynt on hearing Begriffenfelt's profundities : " Truly an extremely gifted man ! Almost all he says is beyond one's understanding." Ling's reputation for those qualities which he lacked has spread meanwhile in certain circles far beyond Sweden. For example, many years ago I came across a good-natured Spaniard (Busque y Torro in " Gimnastico higienica, medica y orthopedica," Madrid, 1856), who calls him " hombre erudito, de vastos conocimentos y de solida instruccion." For my part, I believe that in estimating Ling, or any one else, one does best by seeing things as they are, and I have written of him as I have done, not with a view to lower a deservedly distinguished name, but because I think a more moderate estimation of him in certain directions may render a service to physical therapeutics.

Ling sagely remarks that " it is generally safest to use mechanical treatment last, and to employ chemical while the patient is weakest."

Ling, as was *a priori* to be expected, and as far as one can decide from his indefinite statements, assigns to mechano-therapy all that belongs to it and a good deal more, but in this respect nevertheless he is wiser than many modern gymnasts. He specially excepts from mechanical treatment all febrile illnesses, concerning which he fortunately held the opinion that " the mechanical agent is strong in these, the chemical apparently deficient " (p. 542). On the other hand, he considers scabies suitable for treatment (apparently being ignorant of its parasitic nature, although it had been proved long before his time). This disease depends mainly on " an excess of the internal chemical agent," and can therefore be removed by means of movements, *i.e.*, by increasing the mechanical agent. Ling saw seventy to eighty persons affected by itch cured in this way, and advises, presumably with the support of the experience he gained by this remarkable chance, " beginning treatment by preparatory movements, and by degrees going on to complete active gymnastics " (p. 540).

Ling loves symbols and metaphors. So he gives us amongst other things the interesting information that the thumb denotes constancy and precision, that the forefinger is instructive, that the middle finger expresses calmness and sense, the little finger ease and grace. Even Ling's fancy seems to fall short in assigning a " part " to the ring finger, and he therefore with praiseworthy presence of mind confines himself to the remark that this finger is seldom used alone.

Ling's system of medical gymnastics was developed and promoted in Sweden by his pupils, Branting, Hjalmar Ling and others, and was studied also by several doctors, especially Sondén and Liedbeck. Abroad, Swedes and others were active in the same direction—Georgii in Paris, Eckhard, Schmidt, Rothstein, Eulenberg and Neumann in Germany, Melicher in Austria, Indebetou and Roth in England, Eichwald, de Ron and Berglind in Russia.

The three Prussians, Rothstein, Neumann and Eulenberg,* are the best known. Rothstein had not a medical education, and his work, which was important from a practical point of view, suffers as to its theory from this want. Neumann was a doctor, but belongs to that lamentable type which, in view of the frequent brilliant results of mechano-therapy, loses all critical sense and works in season and out of season on behalf of this treatment, which he plainly declares offers a prospect of true reform in the treatment of *all* chronic diseases. There is no doubt that he very much damaged his cause. After perusing his two bulky volumes almost with horror, it was refreshing to read Eulenberg's essay on Swedish gymnastics, bearing witness to his medical culture, temperate understanding and scientific way of thinking.

During the first half of the nineteenth century we see no essential advance in Ling's physical therapy anywhere. In France this treat-

* Rothstein wrote, amongst other things, " Die Gymnastik nach dem System des Swedischen Gymnasiarchen Ling," Berlin, 1848—1859, and (along with Neumann) a journal " Athenæum für rationelle Gymnastik." Neumann produced " Heilgymnastik oder die Kunst der Leibesübungen," Berlin, 1852. Eulenberg, amongst other things, " Die schwedische Heilgymnastik," Berlin, 1883.

ment seems to have declined after its short flourishing period in the eighteenth century; I have already mentioned the negative standpoint of Londe (1820) regarding massage. In Germany and in the Scandinavian countries gymnasts were at work in a more or less rational way, and massage on the whole was somewhat neglected. Lastly, in England, where sport partly fulfilled the aims of gymnastics, physical therapy gained no great ground, although we have some noteworthy works * which show that it was alive, and although, as already mentioned, two of Ling's pupils practised there.

The new era for massage began in the middle of the century, and its history, like that of medicine, gives one the same impression, that all that has been gained has, to a great extent, been gained since that time. It had hitherto been considered by few doctors, but had been mainly in the hands of individuals who could not themselves estimate its importance nor introduce it into the world of learning. Now it was more generally adopted in the service of science.

A beginning in this direction was made in France, where one often finds good initiative power (with some lack of perseverance). In the fifties the mechanical treatment of chorea, which had been tried there for a decade, became more and more general. Bonnet, who in his previous work is indifferent to such treatment, in his classical "Traîté de thérapeutique des maladies articulaires," published in 1853, warmly recommends gymnastics and massage in various joint affections. Lastly, Dally's and Laisné's well-known works were written about this time.

But it was the Germanic peoples (and especially the Germans) who rendered the greatest services in this as in so many other directions. A strong impulse was undeniably given by the well-known Dr. Mezger, of Amsterdam, who worked as a masseur from the beginning of the sixties, and who in an almost unheard-of degree had the power of winning general confidence, and also had, through his German and Scandinavian pupils, a very great influence on the position of massage in the medical world. The formerly despised method of treatment was taken more and more under the protection of some of the most prominent heads of the great German and Austrian clinics, and was used by doctors whose names ennobled their method of treatment. When Langenbeck and Billroth pointed out the importance of massage; when later Hueter, Esmarch, Barbieri, Volkmann, Gussenbauer, and many others began to use it; and when its effects were scientifically demonstrated by them and others, people in Germany and Austria began to see that massage and medical gymnastics had the same claim to be examined as other branches of mechano-therapy, or as treatment by chemical, thermal, electrical and other means, and that the fact that they had been much misused and advertised by charlatans could equally little lower or raise their real worth. In the north, especially in Sweden, which since Ling's

* "The Muscular Motions of the Human Body," by Dr. John Barclay, Edinburgh, 1808. "Illustrations on the Power of Compression and Percussion on Rheumatic Gout and Debility of the Extremities," by Dr. Balfour, Edinburgh, 1809. "A Full Account of the System of Frictions as adapted and pursued with the greatest success in cases of Contracted Joints and Lameness from various causes, by the late eminent surgeon, John Grosvenor, Esq., of Oxford," by William Cleobury, 1825. "Therapeutic Manipulations or Medical Mechanics," London, 1840, by Ling's Swedish pupil, Indebetou.

time was the home of massage and medical gymnastics, Ling's pupils, especially de Ron, Thure Brandt and Berglind, helped to strengthen the reputation of these methods of treatment, and Mezger's massage was also represented in Sweden, amongst others by his pupils Berghman and especially by Helleday, in Norway by Kiær, and in Denmark by E. Johnsen.

In the latter part of the sixties Swedish medical gymnastics received a noteworthy reinforcement. About this time Dr. Gustaf Zander began to construct, and to give treatment by means of, his most ingeniously thought out apparatus. (Some people, I know not why, have a certain objection to calling these apparatus machines, although they are partly driven by steam.) By means of these apparatus, movements of all kinds are given: active movements, most concentric and eccentric resistance movements, movements regulated by balance wheels, passive movements. Some of the apparatus concern massage; of these the vibrators in particular work excellently. On the whole one may say that the Zander "medico-mechanical" method aimed at and succeeded in partially replacing manual work in the Ling treatment by apparatus and steam power. Moreover, in some—for example, in the rhythmical movements regulated by balance wheels—it has gone beyond Ling's manual treatment. Although I cannot refrain from expressing my opinion that the Zander treatment, as well as the manual method, is in these days and by many of my colleagues too highly estimated in regard to its therapeutic range, I will also express my hearty recognition of the great talent of the inventor, of the inherent importance of the subject, and especially of the service it has rendered in spreading the knowledge of mechano-therapy.

During the last quarter of the eighties massage reached a secure position in the medical world, especially in the Germanic and Scandinavian countries. A whole literature arose in which certainly a great many literary products of very minor importance may be found. Meanwhile, many seriously helped on mechano-therapy, *e.g.*, Mosengeil, Zabludowzki, Schreiber, Reibmayer, Nebel, Hoffa, Maggiora, Dujardin-Beaumetz, Keller, Gopadse, Bum and others. I, too, have a right to claim a place for my own name in this catalogue, chiefly because of the influence the German and English editions of my "Manual of Massage" have exercised on the position of this treatment in Europe and America, and because the Swedish editions have now for close on twenty years been the chief printed guide for students of this subject. In England, however, massage is much less used than it should be, and much less than it is in Germany and Austria.

In the United States of America massage is somewhat more used. The quality of its exponents varies much, as almost everything does in this rapidly developing giant community; a considerable number of the workers are Swedish men or women, more or less fully trained "medical gymnasts." On the whole their work is beneficial. I would point out in this connection that a masseur or gymnast may be excellent in his practical work, be he ever so ignorant of theory. One of the best-known and best Swedish "gymnastic directors" believes that when he kneads the abdomen he transfers the patient's digestive juices by his nerves to his own abdomen, but in spite of this absurd idea he kneads the abdomen

to perfection. In the United States there are many workers who practise a more or less rational massage to which they give the peculiar name "osteopathy." They are almost all very ignorant of anything but the purely mechanical work, but with that often obtain very good results.

Among the first doctors who used massage extensively in the United States was the elder Sayre. Weir-Mitchell, in Philadelphia, by the weight of his authority has greatly helped the spread of massage, which plays an important part in his well-known rest and feeding cure. His son, John K. Mitchell, has written an important work on massage.

* * * * *

It may also be interesting to glance at mechano-therapy, especially massage, as a "popular remedy," in which character we find it more or less general and more or less developed amongst all the races of the world.*

In Europe massage is found everywhere, and many "wise men" (or women) in the country or in towns have it to thank for their best "miraculous cures." It seems most general in our part of the world among races of Mongolian origin. Amongst the Hungarians and Finns it is still much used along with baths, and besides this is met with in many forms (especially as "abdominal kneading"). Amongst the Lapps I have seen it used for "rheumatic" affections of muscle.

In Africa general massage is used along with baths by races on the outskirts of civilisation (as it is by all "Oriental" nations); local massage is also used. Some French authors (Seré, Quesnoy) assert that massage exists amongst all the black races. Amongst the savages of the interior and the south it does not seem to be in very general use; although at times in accounts of travel one sees statements which point to its existence.†

In Asia massage is widespread, is definitely developed amongst the higher races, and is performed by skilled workers. The conditions are the same among the Chinese, where, as with us, barbers especially dabble in this treatment. Travelling in Japan one may often see blind individuals in the evenings strolling about the streets in the large towns, now and then announcing their presence to the public by blowing a few notes on a little pipe. These are the humble masseurs of Japan, who are not at fault as regards their touch, but who have probably an even scantier supply of knowledge than their European colleagues "the gymnasts." One of my friends, who for several years resided in Japan as a doctor, during a visit to a tea-house complained of constipation, and was astonished by the kindly offer of a waitress to remove his trouble by abdominal massage. The conditions among the Hindus are similar.‡ Dr. H. Stolpe of Stockholm, who took a number of interesting photographs in India, showed me one taken at the river bank in Benares of a Brahmin whose leg is being massaged by another dark-skinned individual, probably a "professional." The Malays, too, use massage extensively (*Pidget-ten*).§

* Bartels has published an essay (Leipzig, 1893), "Die Medizin der Naturvölker," which I have not been able to obtain. I have contented myself with the above short miscellaneous notes on massage among foreign races.

† Thus Charles John Anderson, in his work "Lake Ngami," mentions a proceeding used by the Namaqua doctors which is evidently a kind of abdominal massage.

‡ Hünerfauth: "Geschichte der Massage," Berlin, 1886, see p. 8 on Dr. Stein's experience in Java.

§ "Athenæum of Rational Gymnastics," Berlin, 1854, Bd. iv.

The aborigines of America are not entire strangers to massage. It is found among the Redskins of North America, although it seems to play no essential part in their therapy.* Further, one hears of it among South American Indians, with whom massage seems to be somewhat general judging by the repeated stories of it found in tales of travel.†

In Australia massage is found among the low aborigines ‡ of New Holland as well as among the more advanced races of the island groups § of the Pacific. Among the last-named people it is used both as general (chiefly as a " restorative measure ") and local massage, and seems to have reached a definite technical development. The different manipulations are classified by the natives of Tonga much as with us.

* * * * *

For the medical worker massage is often more important than gymnastics. The latter is certainly more important in diseases of the respiratory and circulatory organs, in dystrophic conditions and in certain nervous diseases, and in connection with orthopædics plays a more vital part than massage in the treatment of deformities and anomalies of position. But gymnastic treatment, especially in respiratory and circulatory diseases and the commonest dystrophy, obesity, is carried out in its fundamental and most effective form, as " terrain-cure," which only differs in a slight degree from the everyday movements of the human body, and which the patient, after a few short descriptions, can perform on his own account. Even the essentials of Frenkel's gymnastics for ataxic patients can be arranged with quite simple means, and can be carried out with a little help from the doctor or trained gymnast. In resisted and other gymnastic movements, which require something besides the patient's own body, apparatus can more easily replace the work of the gymnast than that of the masseur on the soft tissues.

* I have received definite reports of this from American doctors, and especially of the existence of *tapôtement* with a therapeutic aim. Reports of it are also found in some of the better known descriptions of North Indian life. On the other hand, in Schoolcraft's great work " Indian Tribes " (Philadelphia, 1853—1860), in a somewhat detailed account of Indian therapy, there are no references to anything which could be considered massage. While on a visit among Shoshon Indians in Utah I heard from one of them that they are in the habit of using kneadings to cure " aching in the body."

† Franz Keller Lenziger speaks of a cure (" Von Amazonas und Madeira," Stuttgart, 1874) which a medicine man (*payé*) of the Cazowa Indians living near Madeira River undertook for " painful rheumatism " and which (except for some mystic decorations) consisted of his giving the patient very strong massage, and began " ihn alsdann von Scheitel bis zur Zehe und zwar mit solcher Heftigkeit zu streichen und zu kneten dass dem Beschwörer sowohl wie dem Patienten der Schweiss in Strömen vom Körper rann." It is worth noting that the Indian *payé* asserted that he transferred the patient's illness to his own body, exactly as a renowned Swede with little less authority professes to treat the highly civilised inhabitants of London. Dr. K. von den Steinen (" Durch Central-Brasilien," Leipzig, 1886, p. 260) tells of a medicine man among the Yuruna Indians who gave what must be considered " general massage " to a sick woman.

‡ Baudin : " Voyage dans La Nouvelle Hollande," Paris, 1800.

§ One comes across many reports of massage in the Islands of the Pacific. The first sailors who visited Tahiti made its acquaintance there. It is mentioned by Wallis, who visited the Islands in 1767, and by Forster (" Cook's Second Journey "). Dr. Emerson speaks of it (in Beard's " Neurasthenia ") in the Sandwich Islands, and lastly we find in the interesting article in the *Gazette des Hopitaux* (of 1839) that in the Tonga Islands manipulations are divided into " mili " (effleurage and friction), " fota " (*pétrissage*) and " toogi-toogi " (*tapôtement*). It is a pity that the French did not learn from the kindly inhabitants of Tonga their classification of manipulations ; it is distinctly more rational than their own, at any rate as found in Estradère's book.

Massage, on the contrary, can only in exceptional cases be performed by the patient himself, and is infinitely more important than gymnastics in the commonest cases of illness. The different muscle infiltrations alone, rheumatic, traumatic and others, and chronic constipation form much the greatest number of all the cases suitable for treatment by manual or "medico-mechanical" gymnastics, and in these, in spite of the gymnast's misrepresentations and assertions, any other kind of gymnastics than ordinary everyday bodily movements is quite unnecessary. Even in the mechanical treatment of joint affections, in which certainly passive movements play a definite part, massage is much more important than gymnastics. It is no exaggeration to say that among those whose occupation is massage and gymnastics, gymnastics does not represent 5 per cent. of their work. It is also no exaggeration to say that every middle-aged or elderly person has at some time been in need of massage, and that a great many people need it for long periods of their lives.

* * * * *

An enormous need for physical therapeutic work is thus making itself felt all over the world, and will be felt the more as more knowledge of the value of massage reaches the general public. At the same time in all civilised countries a numerous class of medically untrained workers has arisen who earn their living by massage and to a less extent by gymnastics. The existence of such a class of workers is an absolute necessity, since the general need for the treatment in question is much greater than could be fulfilled by doctors. The busy doctor often refrains from mechanical work, for which he not seldom lacks the necessary physical strength and inclination, and which seems to him monotonous and tiresome, accustomed as he is to more purely intellectual occupation. In almost every case it can without the slightest danger be carried out by workers whose training is less expensive, and whose services are therefore cheaper. Most doctors who employ massage and medical gymnastics in their practices know from experience that they can often hand over such treatment after a short period of supervision to some untrained but intelligent and handy attendant.

It is, however, better that massage and medical gymnastics should be carried out by some one accustomed to it and with sufficient knowledge in his own line. Such a worker must know a certain amount of anatomy and physiology, studied with special reference to his work. In studying this he has a right to "skip with discrimination." He need not study the deep nerves of the head, but it is important that he should understand the knee-joint; he can safely leave the mechanism of the accommodation of the eyes an open question, but he must know the forces which influence the flow of blood in the veins; he need never hear of acute yellow atrophy of the liver or of acromegaly, but it is of great importance for him to be familiar with inflammation and its various products. He must also be skilled in technique. The uncritical enthusiasm which mechano-therapy, with its often splendid results, is apt to arouse in medically untrained workers renders it necessary that they should learn from the beginning that there are many diseases and conditions which cannot be benefited by massage and gymnastics, and various conditions which

render all such treatment dangerous. But there is *one* item of knowledge which is of the greatest importance both for himself and others, and which his teacher should take great pains to instil. He must be fully aware of the limitations of his own medical training, and that nothing less than a doctor's full training justifies completely independent work as a physical therapeutist. The more he sees of the training required by a doctor, the greater the difference there is in length of study and other things between himself and the latter, the less pretentious the title he himself bears, the easier will it be for him to feel his incapacity for independent work and to submit to supervision by a doctor; the more difficult also will it be for him to convince the general public of his having any just claim to such independent work. To this independence the work of the medical gymnast and masseur offers many temptations.

In Sweden everything possible has been done to create unsuitable conditions for mechano-therapy.

No one is bold enough or narrow-minded enough to defend the fact that in our medical education, especially at the Carolinska Institute, there is no instruction whatever in medical gymnastics and massage, nor even any recognition of the real practical value of a therapeutic method which is both easily learnt and extremely efficacious. And no one can think it reasonable that doctors who must be acquainted with the method of preparation and the appearance of every drug in the pharmacopœia are for the most part quite unversed in such an effective remedy as this. To supply this omission the Central Gymnastic Institute was founded.

The Institute has, however, been a partial failure because it has tried to combine aims which cannot suitably be combined. It aims at being—

(1) a place for training teachers of military gymnastics;

(2) a place for training teachers of educational gymnastics;

(3) a school for mechano-therapy.

The first two aims may very well be combined. School gymnastics stretches out one hand to military gymnastics and exercises and serves as a preparation for military service, while stretching the other hand to sport, the drama and games.

It is, in spite of the frequently repeated paradoxes from the Institute, as absurd to insist that a medical gymnast and masseur should be familiar with educational gymnastics as to insist that a truss-maker should be a shoe-maker, and as wrong to start an institution which is to be at the same time a (military or other) school for educational gymnastics and a school for physical treatment as it would be to establish something which should be at the same time a shoe factory and a factory for orthopædic instruments and apparatus.

A school for physical treatment must live within the medical world, otherwise it is like a separate society, which breaks away and artificially separates itself from and becomes hostile to the world to which it belongs. This has happened with the Central Institute. A more antagonistic spirit than that which rules there against medicine and its workers cannot be imagined, and except when there is some external advantage to be gained, the Institute will have as little as possible to do with the medical world. The Institute has therefore no power of attraction

for medical students, and least of all for the better equipped among them.

It was, moreover, an unheard-of and calamitous blunder to couple the teaching and practice of two such different things as educational gymnastics and physical treatment, and this was done for no other reason than that a fencer and gymnast won for himself a brilliant name in the latter.

Lastly, the law of 1887 crowned a real work of destruction, and it is chiefly due to the utter lack of wit in " the Centralists " who were the authors of this law that it has failed to do great harm. The law, which was entirely in the interest of " the Gymnastic Directors," and entirely against the interest of the general public, enacted that no one except a doctor or some one trained at " the Central " should have the right to treat by medical gymnastics, and this only according to the written prescription of a doctor.

This law lead to the absurd and mischievous diploma of " Gymnastic Director," which can easily be misrepresented to the public, giving a false idea of its value.

The majority of " Gymnastic Directors " have not troubled themselves in the least about written prescriptions from doctors, and the doctors, who seldom understand medical gymnastics, have not troubled themselves to write prescriptions.

But instead, the " Gymnastic Directors " have granted so many more diplomas, and have persuaded the public and themselves that this diploma has the same meaning in the domain of physical treatment as the doctor's degree has in general medical practice.

The law, however, says nothing about massage, which is well. And massage constitutes more than 90 per cent. of this work. But " the Centralists " will not recognise the word " massage," because it apparently came from abroad, and the public did not so quickly associate the idea of massage as that of medical gymnastics with " the Central." They therefore hate the word " massage " and preach the absurd doctrine that its manipulations form part of the passive movements of medical gymnastics. In this hatred lies the reason why the term is omitted from the law.

For this and other reasons, as might have been expected, the law fell to the ground. Many workers learnt massage without devoting much time to the comparatively unimportant subject, for them, of medical gymnastics, and without giving any time at all to the quite useless subject, for them, of educational gymnastics. To crown the errors of " the Centralists " two institutes arose outside " the " Central," which along with the unnecessary two years' course gave the equally unnecessary " diploma," but performed the necessary service of forming much better schools for physical treatment than " the Central." (These institutes are Dr. Arvedson's in Stockholm and the South Swedish in Lund.)

The " Gymnastic Directors " went quite astray concerning the monopoly of this new means of livelihood, especially in regard to that frequently excellent means of livelihood, massage ; and they must have met with this misfortune in any case, since it is practically impossible

to maintain such a monopoly. The "Gymnastic Directors," however, did not understand this.

The Scandinavian Association of Gymnastic Teachers, the greater number of whom are "Centralists," next went to the King with a request that the King might declare massage to be medical gymnastics, and decree that no one, except a doctor, who had not gone through "the Central" course should practise either the one or the other without becoming liable to more severe punishment than had hitherto been the rule in cases of quackery.

His Majesty referred the matter to the Medical Council, the Medical Council referred it to the Swedish Medical Association, and the latter referred it to a Committee.

The Committee expressed itself caustically on the utterly preposterous proposals, proposals contrary to the public interest, refused the "Gymnastic Directors'" amusing request that massage should be declared medical gymnastics, and pointed out that it was a question of different methods of treatment.

The Central Institute, however, without the capacity of being a good school for physical treatment, continued to produce a set of ill-trained workers to practise quackery who were hostile to and independent of the medical profession, spiteful to and persecuting each other, and prone to advertisement.

If quackery were their greatest fault, for my own part I should criticise them mildly. Those who regard the matter calmly can never be inclined to act with great severity against quackery. For instance, it cannot be denied that quackery has its good side, and the history of both medicine and surgery shows that mankind has gained much from it, that is, from the remedial work of persons without medical education. Physical therapy in particular has cause for gratitude to several such persons, especially to several German and Swedish "quacks," among others to our own great man, H. P. Ling. People of great gifts often go their own ways, perform great things without studying for examinations, and help to protect the qualified world from too much routine, trust in authority and exclusiveness.

But the quackery of "the Centralists" is particularly harmful, since, in spite of an utterly insufficient training, it is supported by titles and a legal diploma, which puts it in a false light, and the nature of the diploma is not understood by the public.

And to crown all, these quacks persecute their rivals, who often stand far above the "Gymnastic Directors" in ability and knowledge, with rancour and sometimes with boundless ignorance of the subject, try by hook or crook to make the greater part of physical treatment into a monopoly for themselves, and would willingly exercise a tyranny as merciless and reckless as that of any socialistic trades union. I refer medical readers to the newspaper articles written especially each spring by women "Gymnastic Directors," with their naïvely selfish aim, their mean impudent tone to rivals and opponents, and their amazingly ignorant opinions in regard to mechano-therapy.

Meanwhile an important thing happened in 1910, which should mean the beginning of the end of these impossible conditions.

The Council of the Carolinska Institute, in accordance with a resolution passed unanimously by the members present at the meeting, approached the King with a request that a Committee should be appointed to consider, along with the reorganisation of the Central Institute, the question of instruction for medical students in medical gymnastics and massage. The object of this resolution was that a department for such instruction should be opened in this our chief medical school.

If this takes place, and it seems incredible that it should not speedily do so, the Institute of the Gymnastic Directors, in spite of all other possible conditions, must certainly, though perhaps slowly, continue its way to destruction, a result to be desired in the interests of physical therapy and the general public. Every impartial doctor with a knowledge of physical therapy must be the sworn foe of this Institute.

. " The Centralists " evidently had their eyes open to the danger threatening, and set in hand an energetic and well-calculated tactical manœuvre as a counterstroke.

After having until now praised the Central Institute to the skies, they began to speak of the necessity for the reorganisation of the Institute—chiefly with the object of saving it as a school of physical therapy.

The Government met them so far as to appoint a Committee and to exclude from this Committee the man most distinguished in Sweden for knowledge of the subject and most dangerous to " the Centralists." I mean Dr. P. Haglund, the foremost Swedish doctor now in his prime, who has *exclusively* devoted the work of his life to physical therapeutics, not only to massage and medical gymnastics, but also to surgical and non-surgical orthopædics. That he was not appointed to the committee was of itself a sufficient answer to the question asked here and there on the publication of the members' names : " What does it mean ? "

A still more suggestive and astounding fact is that on this Committee appointed for an administrative public health purpose, there is not a single doctor who is in practice.

The Chairman of the Committee, Dr. S. Von Friesen, a man of brilliant culture, is obviously able to grasp quickly a subject entirely new to him. Professors Johansson and Fürst are the two members on the Committee in whom one might place the greatest hope. But these gentlemen are not doctors, and it is not impossible that the Committee's proposal may be the worst possible.

What would be the worst possible ?

It would be that, for the benefit of " the Central" and the " Gymnastic Directors," but to the detriment of physical therapy and of the public interest, " the Central " should be continued as a school for physical therapy and educational gymnastics.

That thus for the benefit of " the Central " and the " Gymnastic Directors," but to the detriment of physical therapy and of the public interest, the unsuitable combination of the instruction and professional training in physical therapy and educational gymnastics should be continued.

That thus for the benefit of " the Central " and the " Gymnastic Directors," but to the detriment of physical therapy and the public

interest, the unsuitably long and ill-used time of training should be kept up, or possibly even increased in length, owing to arrangements to meet unwise demands for preparatory study.

That for the benefit of " the Central " and the " Gymnastic Directors," but to the detriment of physical therapy and the public interest, the showy title of " Gymnastic Director " should continue to be given, and that everything should be done with the (hopeless) object of gaining for them a monopoly in massage and medical gymnastics.

All this would form the worst and most unwise scheme that the Committee could propose, and it is much to be feared that it is just what it will do.

On the other hand, what *should* be done ?

In the first place, instruction in massage and medical gymnastics should be inaugurated in the Carolinska Institute; and the physical therapeutic school of the Central Institute, and the combination of physical therapy with educational gymnastics, as well as the institution of Gymnastic Directors, should be brought to an end.

A State Institution in alliance with the medical profession should be formed (after the example of the Gymnastic-Orthopædic Institute) for the training of men and women medical gymnasts and masseurs, and these should receive a diploma to show that they have passed an examination in their work.

Private competitors against this State Institution should not be done away with, since they have an enlivening effect and protect against the apathy of routine. But by means of inspectors and other control the good quality of these private institutions should be secured.

All this should be done, and it is possible that it will be done. But if it is done, it will in all probability not be due to the existing Committee, but to the body of the medical profession in Sweden, which might well have a decisive word in the matter, and indeed has this decisive word in regard to its practical application, and if it follows its already expressed opinions will render the Committee's decision null and void.

Even in this way we should not put an end to quackery. But we should be doing our best, not as at present, to make easier, but to make more difficult, the independent practice of physical treatment, especially of massage and medical gymnastics, by medically unskilled persons, and we should obtain a numerically sufficient class of competent workers who would not be encouraged in, and even strongly tempted to, quackery by showy titles and absurdly long and futile courses of training. As regards quackery, the Gymnastic Directors who practise it daily may ceas to trouble themselves over the comparatively innocent practice of it by others. Quackery will always be kept within reasonable limits by the enlightenment and sound intelligence of the Swedish people, the professional and moral character and consequent influence of the Swedish medical faculty, and the penal regulations of the general law against those who inflict bodily injury.

In the spring of 1911 the medical profession in Sweden stated its position in regard to the " gymnastic question." The medical associations expressed themselves unanimously in favour of teaching in mechanotherapy being given in the Carolinska Institute, and the majority of these

associations also expressed themselves unanimously or with large majorities in favour of separating the teaching of medical gymnastics from that of educational gymnastics, of the Central Institute ceasing to be a school of mechano-therapy, and of the training of masseurs and medical gymnasts being taken over by medical institutions. When a motion to adopt or reject an expression of opinion in this sense was put before the Medical Society of Stockholm the motion was carried by 85 votes to 3.

CHAPTER I.

THE MEANING OF MASSAGE AND ITS TECHNIQUE.

Massage means a manipulation or handling of the soft tissues by movable pressure in the form of stroking, rubbing, pinching, kneading or beating performed with a therapeutic aim. This is generally applied by hand, but can, of course, also be given by means of instruments and apparatus of different kinds.*

To limit accurately the term "massage" it is necessary in the first place to distinguish it from *medical gymnastics, which is treatment by means of exercise of the organs of the motor apparatus.* At a first glance at these definitions confusion of ideas seems unlikely. They have for long been denoted by different terms, and their existence has been distinguished both by the general public and by doctors. But the two methods of treatment have several points in common; they must often be used together therapeutically and are often performed by the same craftsman. Strangely enough, the idea had never to my knowledge been definitely and clearly defined in literature before I formulated the two definitions, and pointed out the difference in my "Manual of Massage" in 1888. In a concrete case the differences stand out so sharply that one can scarcely understand that any one, especially any one practising massage and gymnastics, should have been unable to grasp them. One can, for example, massage an infiltration or a hæmatoma, since they are in a sense soft tissues, but it is impossible to apply gymnastics to them, since they are not organs and certainly not organs of movement. A muscle, on the other hand, can be treated both by gymnastics and massage: in the latter case it is treated not as an organ, but simply as a tissue (*e.g.*, in getting rid of an infiltration by friction); in the former case it is used as an organ, and as such must act by shortening and lengthening, or by performing static work to maintain a position. The fact that massage by getting rid of the infiltration raises the muscle's functional power, and in this has the same aim and to some extent the same effects as gymnastics, as well as the fact that gymnastics used along with massage helps to get rid of the infiltration, in no way contradicts

* The French word *massage* may be derived either from the Arabic *mass* (to press), or from the Greek μασσεῖν (to rub).

the legitimate distinction between these two methods of treatment, which coincide neither in their character nor in their effects. *In contrast to gymnastics, massage is not treatment by exercise.* On the other hand, passive as well as active gymnastic movements constitute treatment by exercise. Opinions may differ as to considering passive movements exercise-treatment for parts of the motor apparatus other than the joints. Passive movements, however, are the part of gymnastics most closely allied to massage. Positions, too, are exercise of the motor apparatus, especially for muscles and nerves, and obviously belong to gymnastics and not to massage.

We must also distinguish from massage some manipulations which even gymnasts cannot say belong to gymnastics, but which are sometimes assigned to massage. Static pressure, whether it can be reckoned in orthopædics or not, can under no circumstances be included in that division of physical therapy which is called massage. Similarly one must exclude from massage those manipulations which are performed in order to replace an organ or part of an organ from an abnormal position, *e.g.*, taxis in case of hernia, manipulations through the abdominal wall to release an invagination or volvulus, replacement of the uterus, etc. Some obstetric manipulations I also consider outside the province of massage, Kristell's method of expression of the fœtus, Crédé's method of detachment of the placenta. For my own part neither do I regard as massage the strokings by which in a skin wound one can get rid of the air in traumatic emphysema. Lastly, I also exclude from massage the method (in more than one sense heroic) employed in England by Teale, Sir William Fergusson and others, of causing detachment of parts of the contents of an aneurysmal sac by kneading, with consequent embolism of the peripheral arteries, leading to complete consolidation of the aneurysm. Lastly, we cannot consider as massage manipulations for the introduction of medication, *e.g.*, rubbing which is performed for the inunction of mercury.

* * * * *

The technique of massage is peculiarly important, since its effect depends on the method in which it is performed. But massage as an art is easy, requiring less practice and skill than many other of the mechanical tasks in which every one of us must have a certain skill, *e.g.*, the use of the laryngoscope or the catheter, the common typical operations, etc. For those who from the standpoint of anatomy, physiology, and pathology know what is present in individual cases, the different manipulations come as it were of themselves. In this there is the greatest difference between the scientifically trained and the uneducated masseur. The former has during his years of medical study travelled over most of the ground which leads to becoming a good masseur; for the rest he only requires comparatively short study, normal upper extremities of average strength, hands neither too thin nor too small, and some

aptitude for mechanical work. Further, it is a great advantage to watch or help a skilled masseur for some time. One thus acquires the technique more easily and surely than in any other way, and, besides, gains more quickly knowledge which belongs especially to the masseur and can only be slowly obtained from one's own experience. I would emphasise, on the other hand, that it is never worth while to follow slavishly a definite example in technique, but every one must work out his own method, which soon becomes as individual as his handwriting. It is obvious that manipulations which have quite the same effect on the patient may be performed in many different ways by the masseur. A good masseur thinks less of the way in which he moves his hands at his work than of the tissues he is working upon, and the quality of his massage depends to a very great extent on his knowledge of their condition.

For such knowledge, besides the above-mentioned studies, the power of palpation is necessary ; skill in this respect is the masseur's most difficult task, and can only be acquired and maintained by practice. (The examinations which specially concern the masseur are mentioned later.)

The manipulations which are met with in massage have been classified in very different ways. Many of the scientific exponents of massage are, however, fairly well agreed in distinguishing four different classes of manipulation, which are generally denoted by French names, and are :—

1. *Effleurage* = *stroking.*
2. *Friction* = rubbing with pressure.
3. *Pétrissage* = *pinching, rolling, kneading.*
4. *Tapôtement* = *blows, slapping, hacking, beating, clapping, shaking, vibration.*

Effleurage (Figs. 1—5) *consists of centripetal strokings performed with varying strength generally over a large surface of skin,* and with a large surface of hand ; with the flat hand, with the ulnar or radial portion of the hand, with the thenar eminence, with the base of the hand, with thumb and forefinger, generally with one hand at a time, but sometimes with both hands together (as when a limb is grasped). Effleurage is a form of massage very frequently used and has a therapeutic aim which constantly recurs in practice. *The chief function of effleurage is to hasten the circulation in the blood and lymph vessels ;* it is therefore often performed over the more important veins, where these are easily affected, as in the front of the neck and in the extremities. Thus in general massage (as in other forms of massage) stroking over the veins of the extremities is used in the form of long strokes from the wrist to the proximal end of the upper arm, or from the foot up to the fold of the groin.

FIG. 1.

In local massage also one often uses effleurage over the superficial veins to hasten the circulation within a comparatively small area. In both cases the stroking is given with very moderate pressure. Again, when one makes use of stroking to press the blood and lymph out of a whole muscle group one uses rather more strength in the manipulations.

Figs. 1 and 2 show effleurage of the leg as it is performed in general massage. Fig. 1 shows the hand of the masseur gliding up over the calf and approaching the popliteal space. When the hand has reached the popliteal vein and effleurage is to be continued over the veins of the thigh, the hand is turned so that the fingers are directed to the outer side of the thigh (Fig. 2), in order to continue the effleurage right up to the groin without risking coming in contact with the external sexual organs.

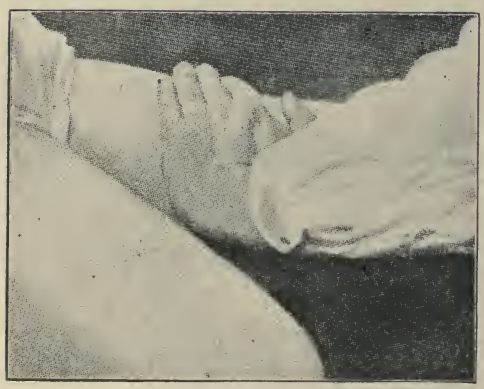

FIG. 2.

Fig. 3 shows a method of performing effleurage over the front of the forearm, the thumbs gliding over the outer side, the other fingers over the inner side of the patient's arm, at the same time going over the large veins in that situation.

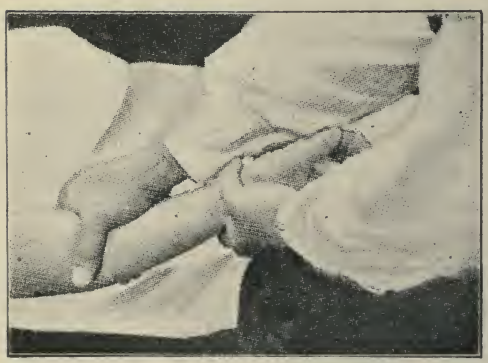

FIG. 3.

Fig. 4 shows another

method of performing effleurage of the forearm. In this the tips of the fingers are towards the outer side of the arm while the base of the hand moves along its inner side.

Fig. 5 shows effleurage over the shoulder-joint, *e.g.*, after a dislocation. The masseur, with both hands flat, performs a circular stroking movement, one hand passing over the front, the other over the back of the shoulder with moderate speed and strength on both sides.

Fig. 4.

Friction is rubbing with pressure, generally performed over small areas, with the palmar surface of the last phalanx of the thumb or of the three middle fingers, but also may be performed in other ways, *e.g.*, with the base of the hand or with the whole palm. Friction is used chiefly to hasten retrogressive changes in inflammatory products, infiltrations and exudations, to press into the outlying lymphatics the disintegration products, and so to promote their absorption. The direction of this manipulation is therefore unimportant, but it is generally necessary to use firm pressure. This is generally possible, but not always. When friction is performed over the eye or over inflammatory products in the abdomen and pelvis, it is obvious that it must be performed with very moderate pressure.

Fig. 5.

Fig. 6 shows friction as it should be performed for rheumatic infiltrations of the neck in the upper part of trapezius or occipitalis. The masseur presses in on the affected parts, performing a small movement with the apposed tips of his three middle fingers.

Fig. 7 shows friction performed by the thumb on the knee-joint

FIG. 6.

over an infiltration in its capsule, an affection called by Swedish doctors " capsulitis."

Fig. 8 shows friction performed over the left supraorbital nerve for rheumatic interstitial neuritis. It is a small matter whether one prefers to use the palmar surface of the last phalanx of the thumb or of the three middle fingers.

Fig. 9 shows friction with the palmar surface of the last phalanx of the middle finger above and through the eyelid for opacities in the cornea. The fingers perform a small movement from side to side with as much pressure as may be given without risk.

FIG. 7.

Fig. 10 shows friction in a case of sciatica due to muscular inflammation, performed with the palmar surface of the last phalanges of the three middle fingers, over the gluteal muscles, which in these cases are often the seat of rheumatic infiltrations.

Fig. 11 shows friction performed with the base of the hand in a case similar to that shown in Fig. 10. It is a form of technique seldom seen but not objectionable.

FIG. 8.

Fig. 12 shows friction with the base of the hand over infiltrations in the back muscles. The remark in reference to Fig. 11 applies also to this.

Fig. 13 shows friction over rheumatic infiltrations in the back muscles given with the

whole palmar surface of the hand, a method less often used but very useful in cases of widespread infiltrations.

It is obvious that since all massage manipulations vary in form and may be performed in different ways with the same effect, and since effleurage and friction in particular have to some extent the same object, in that they promote absorption, there must be various transition forms between the two. But generally speaking, effleurage is performed over a large surface of skin and less pressure is used than in friction.

FIG. 9.

Pétrissage consists of rolling, kneading, and pinching. Its physiological effects resemble those of friction in that it promotes absorption of the products of inflammation, and those of tapôtement in that it is a form of muscle stimulus. These react to a pinch as to a blow by a local contraction and thickening.

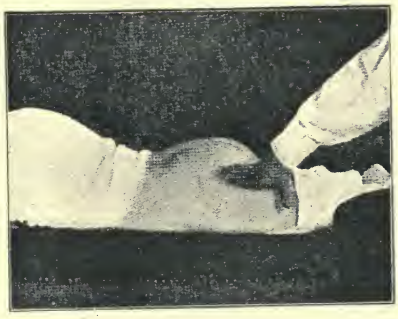

FIG. 10.

Fig. 14 shows pétrissage over the upper border of trapezius, which is a favourite situation for rheumatic muscle infiltrations. The masseur grasps the muscle between his thumbs behind and his fingers in front and lets his hands perform a series of pinching or wringing movements.

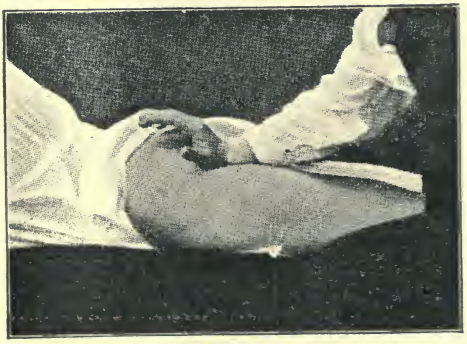

FIG. 11.

Fig. 15 shows pétrissage of the forearm as it is usually given in general massage. The masseur holds one hand on the

FIG. 12.

FIG. 13.

FIG. 14.

front, the other hand on the back of the forearm, and kneads the muscle masses by a movement of one hand against the other.

Fig. 16 shows the same procedure on the upper arm. By their movements against each other the masseur's one hand works on the flexors, his other on the extensor muscles.

Figs. 17 and 18 show pétrissage of triceps on the upper arm. In Fig. 17 the masseur holds his thumb on one side, his fingers on the other side of the muscle mass; in Fig. 18 the manipulation is performed by means of pinchings between the four fingers and the base of the hand; the latter form is much more seldom used than the former. Altogether, pétrissage is a form of massage less often used than effleurage and friction. Used as in Figs. 14 and 17, the manipulation has a diagnostic as well as a therapeutic value, since one can in this way palpate and recognise muscle infiltrations.

Tapôtement (Figs. 19—22) *consists of manipulations which aim essentially at mechanical stimulation of muscles or nerves; these manipulations are all characterised by their blow-like nature* and are named as already mentioned, hacking, beating, shaking, vibration.* We work upon

* Vibrations are, by some authors, considered as a special fifth group of manipulations. They are distinguished however from other forms of tapôtement merely by the greater frequency

the skeletal muscles by beating them all over with the closed fist, by hacking them at right angles to their long axis with the ulnar border of the hand (Fig. 20), or, especially in the case of small thin muscles, as the extensors of the forearm, flicking them with the dorsal surface of the fingers generally held slightly apart (Fig. 21). By shakings performed from side to side with one hand on each side of the patient's abdomen we affect both the muscles of the alimentary canal and its nerve elements. By hackings or vibrations over the head or spine we can mechanically stimulate the cerebro-spinal centres within their bony covering. By chest clapping we stimulate the vagus and consequently produce slowing of the heart-beat and pulse. We affect nerve trunks by percussion or vibration along their course, and lastly, we can stimulate the nerve endings in the skin by different kinds of tapôtement, *e.g.*, by blows with the flat hand or with different instruments.

FIG. 15.

Fig. 19 shows back hackings in standing position as performed by Swedish gymnasts; tapôtement given with the ulnar border of the masseur's hands, the fingers being parted.

FIG. 16.

Fig. 20 gives a picture of tapôtement of the back in general massage. The hands are slightly supinated and strike the back with part of their dorsal surface. The hands go up and down several times on each side of the spine. Tapôtement is often given also over the spine.

of the blows in a given time and by the smallness of the movement. They aim at a similar stimulation and produce similar effects. When vibrations are given by instrumental means on mucous membranes which are difficult to get at by means of the fingers (see later) they are really a substitute for frictions.

Fig. 17.

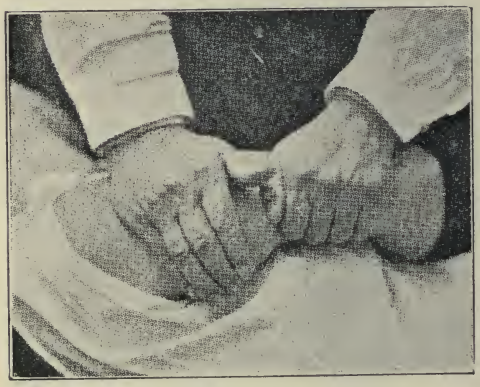

Fig. 18.

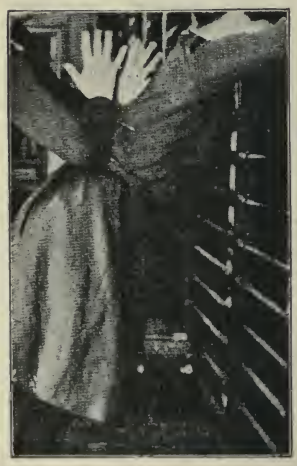

Fig. 19.

Fig. 21 shows a method of performing tapôtement on the dorsal surface of the forearm. The masseur, with fingers held apart, flicks the thin extensors of the forearm with their dorsal surface.

Fig. 22 shows a method occasionally used by giving vibrations without instrumental aid over the posterior nerves on each side of and quite close to the spine. The three middle fingers of the masseur's left hand go down the left side of the patient's spine, the three middle fingers of his right hand down the right side, giving a series of small quick blows. This manipulation requires much practice.

Generally speaking, massage as a whole is performed best by hand, and no instruments exist or can ever be produced with which one can, even approximately, perform the various manipulations that go to a massage *séance* as well as by the hands.

But it cannot be denied that in some cases one may with advantage make use of *instruments*. Certain forms of tapôtement and especially vibrations are performed much more smoothly, quickly, and strongly by means of instruments than by hand.

A great number of cheap, efficacious and durable vibrators are now in the market—the "Veni-vici vibrator," the "Auto-vibrator," the "Medical vibrator,"

etc. Of Zander's well-known and ingenious apparatus most are concerned with gymnastics, but several with massage, and among the latter those which aim at vibrations are, beyond a doubt, those which best fulfil their aim.

Some masseurs use india-rubber balls provided with handles and long or short levers. An instrument for tapôtement looks like a thimble with such a ball at its point. At one time a "palate" was used, a round flat wooden slab on a lever with a handle, to stimulate the skin by repeated blows. At some of the Swedish sea-bathing places different kinds of seaweed, chiefly *Fucaceæ*, are used for the same purpose.

Some masseurs make use in other forms of massage of small wooden wheels, straps, brushes, gloves, sponges; the latter or metal wheels are used at times to give electric treatment along with massage. Most doctors who give massage themselves make use of their hands only, except in the case of instruments for vibration.

The strength of the manipulation is, of course, a very important factor, and varies widely with the different therapeutic aims and the different morbid anatomy underlying the special case. For instance, if one is dealing with a fresh sprain, and massage has chiefly an antiphlogistic aim, one sets to work, especially in the beginning of the treatment, with quite light effleurage; if one has before one an

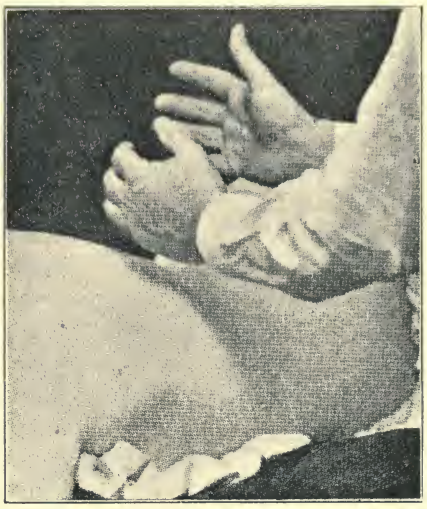

FIG. 20.

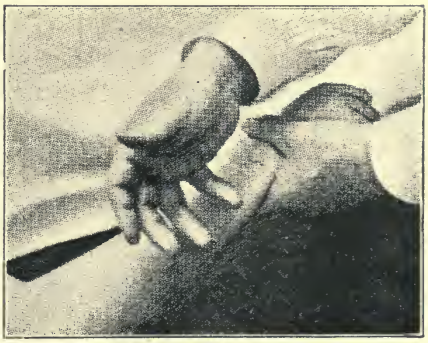

FIG. 21.

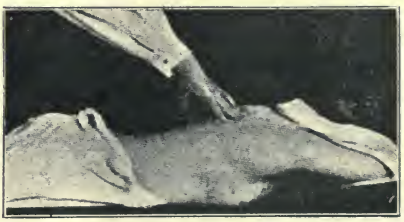

FIG. 22.

extensive hard œdema with a plastic tendency, effleurage as well as friction is firm; if the question is to get rid of already partially organised exudations round a joint after a joint inflammation, one must use hard friction; again, if it is perityphlitic ("appendicitis") or parametric exudation, one must exercise unceasing care, remembering the proximity of the peritoneum and the danger of a new inflammatory process, etc.; all matters which we shall deal with later more in detail, but which in individual cases must be left to the good sense of the masseur. With beginners the commonest fault is to be too hard-handed, but professional masseurs * often tend, on the contrary, to be too superficial. I would especially call attention to the erroneous statement of certain authors that massage should *never* be done hard enough to produce marks of discoloration of the skin, and that every such mark is the "fault" of the masseur. This may be true of general massage and some other cases, but very many of the cases for which massage is suitable (*e.g.*, many chronic joint affections) need such strong massage that marks are necessarily caused. They are of little or no importance and soon disappear.

The length of the massage séance is also important, but there can be no general rule. Several points must be considered in deciding what is enough, and, in the first place, the nature of the lesion. Often in this, as in the strength of the manipulation, one must be guided by the patient's general condition, since nervous, sensitive patients can stand neither a long *séance* nor hard massage. In these cases one must begin the treatment gently and with a short *séance*, gradually increasing the strength of the massage and its duration. For local massage generally a quarter of an hour is suitable. General massage (which is usually done by some one other than a doctor) takes at least half an hour, often more.

In certain acute cases, and especially when used as an antiphlogistic (by means of effleurage), as, for example, in a recent sprain of the ankle, massage should be performed several times a day; in other cases at least twice, never less than once a day.

The masseur should from the beginning accustom himself to use both hands and divide the work fairly equally between them. While he is still new to the work, like other mechanical workers, he squanders his strength and becomes easily tired, but he quickly learns to obtain the greatest possible effect, and can do much more work than seemed at first possible.

The masseur should never make use of narcotics to prevent or

* Busy masseurs are under constant temptation to make their *séances* shorter and less vigorous than is really consistent with the patient's interest, the result of a simple calculation which we leave to the perspicacity of the reader, the consequence being that their work yields quick returns only in an economic sense.

remove pain which he must occasionally cause. The pain is seldom great, and there are other means of counteracting it. Latterly hypnotism and hypnotic suggestion have begun to play a part, in many cases with wonderful success; but I can offer no opinion on the subject, as I have never attempted it.

Massage is almost always given directly on the skin, since in giving it over clothing, as is done by some masseurs in certain cases, one loses technical accuracy. Regard for modesty in a doctor's consulting room can be carried too far, to the detriment of more important considerations, and also to the extent of producing the painful self-consciousness it aims at avoiding. One takes care, especially with women patients, not to uncover more than need be uncovered, and not to uncover at one time more than the part about to be massaged.

Most masseurs make use of some lubricant to make the patient's skin soft and smooth. This is often a necessity, especially for firm effleurage, as otherwise one causes pain by dragging the hairs of the skin, and may irritate the glands of the skin and so cause acne or boils. Different skin lubricants may be used: *glycerine*, *vaseline*, *lanoline*, *lard*, "*cold cream*," *olive oil*, *cocoa butter*, *etc.* Glycerine I definitely condemn, since its strongly hygroscopic properties make it irritating to the skin; vaseline irritates somewhat. Liquid oils are troublesome to handle. Solid cocoa butter is better, but it has a fairly strong smell. On the whole it seems to me that lard should have the preference.

Some masseurs use only *talc* or other powders. In general massage this often seems to me most comfortable for the patient. If, however, the masseur has the good fortune to possess really dry hands he can give general massage without either powder or lubricant.

For deep effleurage, especially over the forearms or legs, it is sometimes necessary to shave the part once or twice a week, otherwise "pimples" may arise.

The masseur's hands must be carefully washed immediately before and after each séance; the nails should not be too long, and no rings should be worn.

The whole *material outfit** needed by a masseur (besides the above-mentioned lubricant) consists of a *couch* of suitable length and breadth, and about 60 cm. high, accessible from all sides, a so-called *plinth*, preferably with one end which can be raised or

* Even this bench is not at all necessary, and of late years I have myself used an ordinary couch. Plinths of different kinds are used in my Institute. During all the many years in which I have used massage in my practice I have used no instrument but my hands and a vibrator. This last should be in the possession of every one who makes much use of massage.

lowered according to need. When massage is given to any part of the back, buttocks, chest, abdomen, pelvis or legs, sometimes even to the shoulder joint, the patient lies on the plinth and the masseur stands or sits beside it. When massage is given to the lower part of the arm up to and including the elbow joint, the patient and the masseur sit directly opposite each other, one on either side of the plinth (upon which the patient rests his forearm). For massage of front or back of neck the patient sits on the plinth, and the masseur stands in front in the first case, behind or beside in the second. The suitable position for the patient is in most cases obvious. Where this is not the case we shall return to the subject in the special chapters.

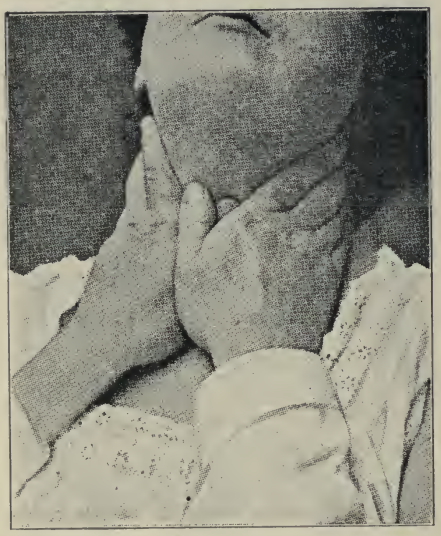

Fig. 23.

* * *

There are many different forms of massage according to the anatomical conditions. Generally massage is *local* and is applied only to a small part of the surface of the body, but it may also be applied to the greater part of the body, and is then called *general.*

The different forms of local massage are described later in their proper places; for practical reasons, and to make the study of the physiological and general therapeutic effects mentioned in the next chapter easier for the reader, we give here a short description of the technique of massage of the front of neck and of the abdomen as well as of general massage.

Massage, or rather effleurage, of front of neck * aims at hastening the circulation in the area of the blood vessels concerned, which are for this purpose favourably situated anatomically. With the palmar surface of each hand pressed against the corresponding side of the patient's neck, and with both hands together, the masseur passes his hands several times from above down with rather firm pressure over the jugular veins in as much of their course as possible, at the

* Massage of front of neck has been used in Sweden at least since the time of Ling, who mentioned it and understood its chief effects. In our days Gerst, Weiss, and others have laid stress on its therapeutic value in various inflammatory processes and hyperæmic conditions of the head (see later).

same time avoiding pressure on the hyoid bone or larynx (see Fig. 23).

Fig. 24 shows the method of giving effleurage of front of neck used by Höffinger and others, standing behind the patient, which seems to me more comfortable and better than standing in front. The illustration is not quite satisfactory, as it gives the impression that the strongest pressure is given near the mid-line.

Fig. 24.

In case of necessity Gerst allows the patient himself to massage the front of the neck, using first one hand and then the other, with the thumb on the corresponding side of the neck passing down over the common jugular vein; the other fingers work over the veins of the other side of the neck.

Weiss employs the following method chiefly for children: in the recumbent position the child's head is fixed by the nurse; the stroking is performed solely with the thumbs while the other fingers encircle the neck.

Fig. 25.

Effleurage of front of neck is performed with constantly repeated strokings for about ten minutes at a sitting; the number of sittings advisable in acute cases may be as many as five to six a day.

In such cases a lubricant is useful. Massage of front of neck is preferably given by a doctor, but may be entrusted to others, as Gerst has shown.

Abdominal massage or "abdominal kneading" aims at manipulating the alimentary canal through the abdominal walls, and is generally given (see later) for chronic constipation. The masseur, holding his fingers hyperextended, places the palmar surface of the three apposed middle fingers over the part which is for the moment to be massaged, with moderate force presses in the abdominal wall,

and, by means of small circular manipulations with steady pressure, kneads or rubs the corresponding part of the alimentary canal, between the anterior and posterior abdominal walls (see Figs. 25, 26). The patient's skin moves with the masseur's fingers and a *lubricant is unnecessary. During this manipulation the masseur keeps his hand fixed in slight dorsal flexion at the (upper and lower) wrist joint, and in the sitting position the movement is divided between the elbow, shoulder, and hip joints.* One hand is used at a time, the right and left moving alternately.

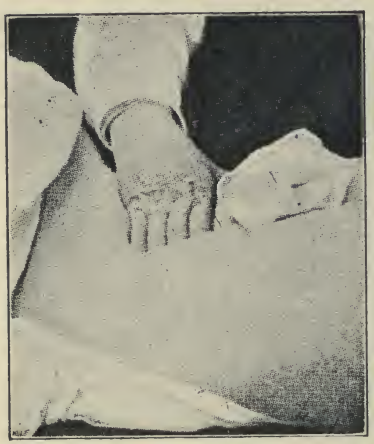

Fig. 26.

In massage of the stomach this manipulation is applied over the gastric and left hypochondriac regions, but reaches only a small part of the organ if it is approximately normal in size. If the stomach is dilated it is to that extent more within reach of massage. By performing the above manipulation more staccato (more after the manner of tapôtement, although the fingers do not leave the abdominal wall), for example, over an atonic or dilated stomach, one can give a stronger mechanical stimulus than by means of the smoother pressure to the non-striated muscle and so produce contraction. Among Zander's apparatus there is a vibrating pellet which vibrates from side to side; by leaning against this with the part of the abdomen required the patient receives a forcible shaking over the stomach and bowels.

Fig. 27.

In manipulating the large intestine one begins over the cæcum, then going over the ascending, transverse, and descending colon and sigmoid flexure down to the symphysis pubis, paying careful attention to every $\frac{1}{4}$ cm. of bowel, except those parts (the hepatic and splenic flexures) which for anatomical reasons cannot be reached. The small intestine is got at by similar manipulations

over the umbilical and lumbar regions. In very severe cases of chronic constipation one should insist on treatment twice a day. The effect of the treatment depends essentially on the manipulation being performed long enough on each part of the bowel before the fingers are moved on to the next; the whole *séance* should occupy at least fifteen minutes.

To empty the contents of the large intestine into the rectum one can afterwards with one hand—or better and more strongly with one hand applied over the other to strengthen it, only one hand coming in contact with the patient's skin—perform stroking over the large bowel, especially over the transverse and descending colon and sigmoid flexure. One can also attain this object by placing the hands one over the other (see Figs. 27 and 28), and constantly moving first the under, then the upper hand a little at a time and without for a moment relaxing the pressure on the bowel. In this one does not press directly downwards all the time, rather upwards, but the whole procedure, which ends over the symphysis pubis, is extremely effective in emptying the contents of the large intestine into the rectum.

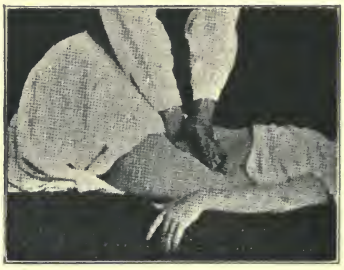

Fig. 28.

In ordinary cases there is no great necessity for the doctor to perform the abdominal kneading, and no danger in leaving it after some instruction to non-medical workers, although it then seldom gives such good or rapid results even when performed in the simple and effective manner above described. It is noteworthy and interesting that, in spite of the extreme simplicity of abdominal kneading and the eagerness of my pupils to learn it, I have great difficulty in getting them to do it properly; and I understand more readily since I have begun to teach these subjects how it happens that so few masseurs can perform the "miracles" so easily obtained in severe cases of chronic constipation. I will refer again to this subject at the end of the next chapter and in the chapter on Diseases of the Alimentary Canal and Abdomen.

The above-described simple technique is that which for nearly a quarter of a century I have found most effective while experimenting with different manipulations on a large number of patients with chronic constipation, and I think from my experience I am giving the reader good advice when I beg him not to waste time on other less effective or quite ineffective manipulations by whatever masseur they are recommended. Many classes of manipulations, so warmly recommended in

some quarters, with circular strokings round the umbilicus, with pressures over the cœliac plexus (half-way between the ensiform process and the umbilicus), and over the splanchnic plexus (half-way between the umbilicus and the symphysis pubis), with sacral beating, etc., are empty "ornaments," or at least of very doubtful and certainly subordinate value, and one only wastes time over them. Strokings over the colon, strongly performed with one hand, or with one hand over the other, are certainly capable *for the moment* of sending the contents of the bowel into the rectum, and thus promote, also *for the moment*, a more immediate action. But this is not the chief aim of the treatment (see next chapter), and the same result is obtained by the manipulations already recommended, which in all their simplicity, when conscientiously performed, gain their end with certainty, although, in severe cases of chronic constipation, often not till after several months' treatment.

*General Massage**, during which the patient lies undressed in bed (and should always be massaged by some one of the same sex), comprises the greater part of the body, begins with the extremities, and on the whole goes from the periphery towards the centre. The patient lies on the back except while the back is being massaged, when he lies on his face. General massage is given by my pupils as follows :—

The masseur begins with the upper extremity, using his hands as follows :—With his opposite (*e.g.*, left) hand he grasps the patient's (right) hand, and with the whole palmar surface of his other hand performs effleurage over the superficial veins of the front and radial side of the whole arm, from the wrist upwards, namely, over the cephalic, basilic, and median veins and their anastomoses (Figs. 3 and 4). After half a dozen such strokes he begins treatment of the forearm by compressing by deep effleurage with one (right) hand the muscles on the anterior surface, and then with the other (left) hand the muscles on the dorsal surface. Pétrissage of the forearm follows, and, like all the manipulations, is repeated a few times. It is performed over the whole muscle mass ; the masseur, holding his thumbs moderately abducted and the four fingers somewhat flexed, grasps the forearm between his two hands, one on each side (front and back), touching it with the palmar surface, with the radial surface of the forefinger, and with the palmar surface of the thumb (Figs. 15 and 16). He then kneads with small, smooth, circular movements, which by degrees, without the hands ever leaving the patient's skin, travel over the whole surface from the wrist to the

* General massage has been used in the interests of health from time immemorial (especially with baths) by nearly all Oriental, as well as by several European races, and it is widely met with as a popular remedy, for example, in the islands of the Pacific. Medically it is perhaps most often used and with much benefit as a substitute for physical exercise when this is for any reason impossible. It plays an important part in the so-called Weir-Mitchell treatment. In dystrophies, "general weakness," and chlorosis it is also of value.

elbow. In the tapôtement which follows he gives light blows with the fist to the thicker muscles on the flexor aspect; to the thinner extensors he gives light blows on the dorsal aspect of the forearm with the dorsal surface of the four fingers of the open hand (see Fig. 21). The muscles of the forearm are then again compressed by effleurage as described above. This finishes the treatment of the forearm. Before going on to the treatment of the upper arm, effleurage over the whole arm may be repeated. He compresses the anterior muscle groups with one hand, and then with the other hand treats the posterior muscles in the same way. In the pétrissage which follows he treats the anterior muscle groups by themselves and the posterior by themselves; he gets at the posterior muscles best by adducting the patient's upper arm in front of his chest (Fig. 17). He then gives tapôtement (best with the fist) over both muscle groups, and again compresses them by effleurage. He strokes, kneads, claps, and strokes again the deltoid muscle by itself, and completes the treatment of the arm by effleurage over the whole.

When both arms have been thus treated the masseur goes on to the lower extremities, grasps with his opposite (*e.g.*, left) hand the patient's (right) foot, compresses with the thumb of his corresponding (right) hand the network of veins on the dorsal surface of the foot, and with a continuous movement strokes with the palm of the same hand over the veins of the calf and the popliteal vein, following the saphenous vein with the thumb (Fig. 1). When the masseur's hand in this continuous effleurage has reached the lower part of the femoral vein on the front of the thigh he then rotates this hand (without breaking off the effleurage which should go with one stroke over the whole limb) so that the thumb, which would otherwise be directed outwards on the front of the thigh, is now directed downwards towards the knee, and the other four fingers, which would otherwise be directed inwards on the front of the thigh (towards the mid-line of the patient), are now directed outwards (Fig. 2). By thus changing the position of the hand, when the effleurage ends at the groin the hand comes near the external genital organs without discomfort.

Treatment of the leg begins and ends, like that of the forearm, arm, and thigh, with compression of the muscles, in which he lets the thumb of the corresponding hand go on the inner side of the calf muscles, while the four fingers encircle them. With the four fingers of the other hand he then compresses the peronei, letting the thumb act in the same way over tibialis anticus. The calf muscles must be kneaded by themselves and tibialis anticus by itself. For tapôtement it is best to use the fists over the thick calf muscles.

In massage of the thigh one divides the muscles into four groups, and treats separately, one after the other, quadriceps femoris, the adductors, the inner flexors (semimembranosus and semitendinosus), and biceps by compressing them in the ordinary way, giving pétrissage, hacking, and compressing again. The best way to place the patient and oneself for comfort and ease in reaching the part is too obvious to mention. After the special treatment of the thigh one again gives effleurage over the *whole* limb.

After finishing the treatment of the leg one next performs abdominal massage, or the so-called abdominal kneading, as above described (Figs. 25—28). It is a very important and effective part of general massage, and should not be omitted without special reason. It should occupy about fifteen minutes.

After abdominal kneading the patient should lie on the face for treatment of the back. Although the anatomical conditions are not particularly favourable for effleurage, to help the circulation we begin and end the treatment of the back with long, quick strokings, carrying both hands one on each side of the spine up and down over the whole surface between the neck and the hips. We knead the muscles over both sides of the whole back by performing small circular movements (Fig. 13) in which the patient's skin accompanies the hand of the masseur. One uses either the palmar surface of the whole hand, or its uppermost part ("heel" or base of hand). We then give a series of vibration-like manipulations with both hands at once, one on each side of and close to the spine, using the tips of the three middle fingers from the neck down to the lumbar region inclusive (Fig. 22), a treatment which has a very stimulating effect, but which, to be given well, needs some practice. Tapôtement is then given in the form of back hacking from the upper part of the chest to the lower part of the lumbar region, the masseur's elbows being slightly supinated and the metacarpo-phalangeal joints slightly flexed (Fig. 20). Not only the ulnar border of the little finger comes in contact with the skin, but also its dorsal surface and that of the ring finger. Both these fingers, and especially the little finger, are held somewhat abducted; many masseurs, zealous of technique, attach great importance to a certain "feathering" done with the abducted fingers, thinking that the power to do this and back hacking altogether offers a very good criterion for a clever masseur. Each side of the back is hacked separately, and then the spine itself in many cases.

Before and after back hacking one treats the muscles of the shoulder blade by themselves by giving effleurage, tapôtement (with the finger tips), and again effleurage above and below the spine of the scapula.

The gluteal regions are next treated in the same way ; but many patients dispense with this altogether. The treatment of the back ends as it began, with effleurage.

With women patients we leave the chest untouched ; with men one can treat the pectoral muscles and subclavius by stroking, hacking, and repeated stroking.

If special indications exist for massage of front of neck, one may suitably end general massage with this.

In general massage all the manipulations are as a rule performed with moderate strength. It is important for patients, especially those who are having a long course of it, that it should be performed comfortably, or at least without discomfort.

If the masseur has quite dry hands, he generally uses no lubricant for general massage ; if not, he uses either a lubricant or talc powder for effleurage.

General massage should take at least half an hour (preferably about an hour), demands little more than mere mechanical skill, and can in most cases be quite well performed by non-medical workers. The doctor in busy practice has seldom time to give it himself, and can entrust it to any trustworthy person *of the same sex as the patient*, after he has once give instructions for the special case.

CHAPTER II.

THE PHYSIOLOGICAL AND GENERAL THERAPEUTIC EFFECTS OF MASSAGE.

In describing the physiological and general therapeutic effects of massage it is convenient to consider each class of manipulation to some extent separately.

Effleurage accelerates the circulation in the blood vessels and lymphatics in the area acted upon and in its neighbourhood. Centripetal stroking as it goes over the skin must compress the underlying veins and empty their contents centrally (Mosengeil). The fact that this stroking is performed in the opposite direction to the blood flow in the arteries does not in a perceptible degree counteract this effect, owing to their more protected situation and more resistant walls. On the contrary, the arterial circulation is hastened by the quicker outflow from the veins and the diminished pressure within them. Immediately after the veins have been emptied this pressure becomes negative owing to the elasticity of their walls, blood is *sucked in* (certainly with no great force) from the adjoining tributary veins, and thus massage not only helps the circulation in the area worked upon, but also in its immediate periphery. In other words, effleurage acts, as Mosengeil aptly remarked, both as a pressure and as a suction pump.

So much for the important effect of effleurage on the circulation in and near its own area. I will return later in this chapter, in connection with the effects of general massage, to the subject of the influence of effleurage on blood formation, blood flow, distribution of blood in the body, blood pressure and pulse—an influence partly due to vaso-motor reflexes.

That the stream in the lymph vessels is also accelerated by stroking (and other manipulations) has been proved experimentally in Ludwig's laboratory, and especially demonstrated by Lassar (1877), and more recently by Buchheim in 1892. In this all manipulations which exert pressure on the tissues have an effect (although in a less degree than centripetal strokings), since the lymphatics as well as the veins are provided with valves which only open centripetally.

I have already indicated that *there are different forms of effleurage*,

corresponding with its different aims. Sometimes, as in general massage and in some other cases, it aims at hastening the circulation in a whole extremity; the strokings are then given with very moderate strength over the superficial veins in their whole length. One often wants to help the circulation within a smaller area, *e.g.*, over the ankle in a recent sprain, and then one gives light stroking only over the ankle and the parts immediately adjoining it peripherally and centrally. Again, in other cases effleurage aims at sending the blood and lymph on from the muscles, and is then given more strongly.

The power of effleurage to help the circulation locally is extremely important, and renders it of great service therapeutically. *Amongst other things it counteracts inflammation in its earlier stages, and is thus in certain cases an excellent antiphlogistic.*

Inflammation begins by a dilatation of the small blood vessels (affecting arteries, capillaries, and veins), a slowing of the blood stream, on which follows crowding of the white corpuscles against the vessel walls, diapedesis or the wandering out of these, and in more severe cases also of the red corpuscles, as well as of plasma from the vessels into the tissues and the consequent increase of cells (and plasma) in the latter. By accelerating the circulation as above described, effleurage prevents stasis and the accumulation of white cells against the walls of the vessels and their wandering out; and in the same way conduces to the carrying off, in the lymphatics, of the cells and lymph already in the tissues. The effect of effleurage in this respect is often palpable in the most literal sense. For instance, in a case of ordinary sprain of the ankle, one often sees a little effleurage produce a visible retrogression of the inflammatory symptoms, the redness, swelling, heat, and pain diminishing rapidly, and the power of movement returning. In this case, as always when one has an antiphlogistic aim, the strokings are performed quite gently, so that they produce as little mechanical irritation as possible.

The power of effleurage to promote the circulation and act as an antiphlogistic peripheally from the area over which it is used has led to its use as a *preparatory form of massage.* For instance, one often begins the massage *séance*, especially in acute cases, with effleurage centrally from the affected area, in order to diminish the inflammatory tension in it.

The secretory activity of the skin is increased by the more rapid circulation and by direct stimulation of the sweat and sebaceous glands, and the exchange of gases by the skin, which in man is trifling, is also somewhat increased (carbonic acid is given to the air and oxygen is taken from it). The temperature of the skin (which is normally about 32° C.)

s raised most by strong effleurage and vibrations (see Mosengeil, Berne, Eccles, Rosenthal) on an average about 2° C. for ten minutes' effleurage, while a rise of nearly 5° C. can be produced by five minutes' vibration. According to Rosenthal this is produced chiefly by friction, and only to a small extent by the more rapid circulation. During abdominal kneading the temperature falls over a large area, probably over the whole body, due to the congestion of the abdominal organs (Eccles, Rosenthal).

The different forms of sensibility in the skin are affected by all manipulations, but especially by effleurage. In this, as in all other directions, the Germans have been active, and their descriptions are often so minute that it seems advisable to refer to them more in detail, so long as the results are uncertain. I think it is not too much to say that in regard to sense of pain, pressure, tactile sense, sense of temperature, and sense of localisation, sensibility is increased by effleurage, if light and not too long continued, perhaps by gentle stimulation of the nerves, perhaps also by the increased circulation. Schmotin, of Berne, found that hyperæmia increased sensibility, anæmia lowered it. Long and strong massage undoubtedly lowers sensibility. The fact that Rosenthal always found with the æsthesiometer that the sense of localisation was lowered might well be due to too strong stimulation. I would refer those who wish to investigate further this point, which is of little practical importance, to Rosenthal's work on massage in 1910.

Owing to its power of helping the circulation, effleurage raises the state of nutrition of the tissues in and near the area worked upon by the supply in the blood of plastic material as well as of material which can be burnt and of oxygen with which to burn it. Effleurage contributes, therefore, *to counteract local atrophic influences ;* this, of course, only in a marked degree when it is used long and frequently. It has for the same reason a great power, when anatomical conditions are suitable, *of influencing favourably the healing process*, which takes place more quickly and firmly with its help. Effleurage is therefore *of use in many cases of injury*, as well as in some cases of defective healing power due to defective circulation or bad condition of nutrition from any cause (*e.g., in ulcer of the leg and in pseudarthrosis after fracture*). Lastly, effleurage for the same reason has the power in certain cases, *e.g., in frostbite, of limiting or preventing a threatening mortification or gangrene.*

Further, on the power of *effleurage* to aid the circulation depends yet another of its properties, which, though less important, has been known from time immemorial, and long before the explanation of it was guessed at, *it removes the substances causing fatigue and has a restorative effect on the respective groups of muscles.* To sum up what we know at present of fatigue, although we have still much to learn, it seems to arise in the muscles from two causes, partly from the fatigue products found as the result of metabolism arising

during muscle work (of these products carbonic acid, lactic acid, and the acid phosphates have been specially mentioned), partly from the lack of oxidisable material and oxygen. Fatigue also affects the motor nerve cells, causing temporary retrogressive changes (see later on " Over-strain "). It has been shown beyond a doubt that effleurage by hastening the removal of fatigue products from the " exhausted " muscles, and by supplying other oxidisable material and oxygen to them, has a strongly restorative effect on the muscles' power of work.

The important results of Zabludowski's, Mosso's, Maggiora's, and Ruge's experiments in massage, especially on the restorative effects of effleurage, may be mentioned along with Ruge's conclusions.

Massage gives both to the rested and the fatigued muscle more strength and endurance and causes stronger reflexes. Three to five minutes' massage has often a greater effect on fatigued muscles than twenty minutes' rest, and produces three to seven times greater manifestation of strength. To produce tetanus in a massaged muscle requires more frequent stimuli than to produce this form of cramp in a muscle not subjected to massage. (This fact was observed long ago by Kronecker and Stirling, and is conclusively proved.)

The restorative effect of massage is undoubtedly chiefly due to effleurage, and this manipulation is also of great value in improving the condition of atrophied muscle. In this respect, however, pétrissage and tapôtement are also very effective. To this subject I will refer later.

Zabludowski, who made many but lamentably uncertain observations on the physiological effects of massage, states that it lowers the irritability of muscle to electricity. This would appear to agree with the fact that a stronger stimulus is needed to produce tetanus in a muscle which has been massaged than in one not so treated.

Rosenthal has performed more careful experiments on this point, which he himself says are difficult to interpret. In this I heartily agree with him. However, it appears from these that massage, and especially effleurage, increases irritability, *i.e.*, that after effleurage it requires a weaker stimulus to produce contractions (not tetanus ; see above).

Mosso's and Maggiora's experiments with Mosso's ponometer and ergograph show that the restorative effect of massage within certain limits is proportional to its duration. With continual muscle work massage loses much of its restorative power, and nothing but rest is able to restore the strength of the muscle.

Lastly, effleurage as well as friction has the power of promoting absorption. Especially is this so with the products of serous inflammations, with fluids and their dissolved salts. Centripetal strokings hasten their removal by the lymph channels, perhaps also

to some extent by the blood vessels. This property of effleurage is best demonstrated in the case of temporary œdema, of which the cause is not permanent, as in a sprain.

* * * * *

Of the various massage manipulations, however, friction has the greatest power of causing the absorption of inflammatory products, especially of cellular inflammatory products (apart from pus).

This holds good along with another proposition—that *all massage manipulations promote absorption.*

Since there are many transition forms between purely serous inflammatory products and those mixed with cells and fibrin, and since, likewise, there are transition forms between stroking over large areas of skin and rubbing over small areas, *i.e.*, between effleurage and friction, it is impossible to draw a sharp line between the many experiments which have been performed with these two manipulations. Mosengeil showed as early as 1876, and since then Sturm and Gallis have proved, the power of massage to promote absorption in connection with joints; Reibmeyer and Höffinger in connection with the abdomen; Zawadski (effleurage) in connection with subcutaneous tissue; Kellgren and Colombo in connection with subcutaneous tissue, joints, abdomen, and muscles; Castex in the case of traumatic inflammatory products of many different kinds, etc.

The practitioner should clearly grasp that the more purely serous, the more recent the inflammatory products are, the more effective is effleurage; the more fibrinous and cellular elements they contain and the older they are, the more does deep kneading, *i.e.*, friction, show its real value in producing retrogressive changes and forcing the final products into the lymph channels and thence into the blood stream.

Friction is of great therapeutic value in connection with hæmatomata, infiltrations in the skin and subcutaneous tissue (cellulitis), in the muscles, tendons, joint capsules, ligaments, and fascia, and in the nerve trunks in the case of interstitial neuritis. Also in exudations in the abdomen, as in appendicitis and perimetritis, in parametritic exudations in the pelvis, in corneal opacities, etc., friction, if necessary with very gentle pressure, is of great use.

I would mention here that all purulent processes, all pus, contra-indicate massage in their neighbourhood. (See *Contra-indications to Massage.*)

Friction can produce disintegration of the tissues and break them up into small particles. This is its most important effect in promoting reabsorption. It also spreads the inflammatory products over a larger area, so that they are more readily removed by the

blood stream. Lastly, the crushing of the newly-formed capillaries by friction no doubt sometimes aids retrogressive changes, since they maintain a higher level of nutrition in the inflammatory connective tissue and help its organisation.

By its power of causing reabsorption of inflammatory products, massage, especially friction, helps to loosen or stretch parts which have become shortened by inflammation, or have become adherent to other parts (scar contractions, peritoneal adhesions between the bowels, fixation of the uterus by para- or perimetric exudations, etc.).

* * * * *

Pétrissage shares the effects of friction and of tapôtement. Pinching produces the same effect as a blow on muscle. A local contraction arises, shown by the thickening of the muscle at the spot pinched, from which waves of muscle contraction may spread in both directions; fibrillary contractions may also arise. In this *pétrissage has exactly the same effect on the muscles as tapôtement* (see next page) and may be used for the same reasons. I need not therefore discuss it as a muscle manipulation, which is its ordinary use.

In abdominal massage, in which one kneads accessible parts of the alimentary canal by means of the anterior abdominal wall against the posterior, and which may be regarded as a form of pétrissage, one produces the same effects on the muscles of the alimentary canal (see later in this chapter).

But pétrissage, like friction, promotes reabsorption. By grasping a portion of the tissues between the fingers, whether it consists of skin and subcutaneous tissue or of these and muscle, and pinching them, by means of this movable pressure one induces retrogressive changes in the inflammatory products, subcutaneous infiltrations (so-called cellulitis), or muscle infiltrations (myositis), and brings about their absorption.

* * * * *

Before I consider *tapôtement* as a means of mechanical stimulation I must first remark that all forms of tapôtement are powerful means of promoting absorption, as is the case with the three manipulations above mentioned. From my own experience I have no doubt that clapping, shaking, and vibrations over the chest can bring about, and in a high degree promote, the absorption of exudations within its cavity, especially in pleuritic cases.

The most characteristic function of tapôtement is that it produces mechanical stimulation, like all other manipulations, but in a higher degree, of muscles and nerves in the first place, but also of protoplasm as a whole, of all cells, and especially of gland cells.

By mechanical stimulation, as by any other stimulation, func-

tional changes in the organism and in its varieties of protoplasm are produced; at least, we believe it is by some kind of stimulation that functional changes are effected. In regard to this subject two facts stand forth. The first is that both the quantity and the quality of the stimulus are important. The second is that the effect of stimulation may be in the direction either of increasing or diminishing function, *i.e.*, exciting or depressing.

Tapôtement of muscle is of the greatest importance as a means of stimulation. A blow, in the same way as pressure or pinching, produces muscular action independently of nerve stimulation, and entirely by reason of the muscle's own irritability (Kölliker, Kühne, Schiff). Contractions of a few muscle fibres ("fibrillary contractions"), or contraction of the whole muscle, or a series of wave-like contractions starting from the spot stimulated, depend upon the frequency and strength of the stimuli. A single blow or knock produces a long contraction at the part stimulated; this leads us to the belief that the remaining portion of the muscle is stretched. Tapôtement along the muscle produces a series of similar local contractions although there is no apparent movement. This method of stimulating paralytic and atrophied muscles is, however, very effective, even when their irritability to other stimuli has ceased. Any one may prove this for himself by striking a dissected muscle with the back of a knife. Tapôtement, as well as effleurage and gymnastics, is very effective in preventing the consequences of long-continued inactivity of muscle.

Massage, especially tapôtement, is an important means of stimulation of nerves. This opens up a wide subject, far from being fully understood as yet. Tapôtement can affect through the soft parts only the nerve endings of the cerebro-spinal nerves and their branches. But tapôtement may be given in the form of shaking over the head and spine, and so stimulate the central and peripheral nerve substance and its ganglion cells inside the bony cavities. In regard to the internal changes occasioned by such stimulation we are still sadly ignorant.

We have possibly an example of the therapeutic value of stimulation of the central nervous system in the curative effect of hacking and vibrations over the cranium in cases of neurasthenic sleeplessness, a view strongly held by Charcot, Gilles de la Tourette, and others. The effect of such treatment may possibly be due to changes produced in the circulation and to the resulting stimulation of the ganglion cells.

Many masseurs make use of hacking and vibrations over the spine because of their beneficial influence on the cellular elements of the grey matter in the spinal cord.

Tapôtement or vibration on the peripheral nerve trunks or their endings has a direct influence on the nerves themselves, as well as a reflex influence on other nerves; in both these ways we can produce sensory, motor, secretory and vaso-motor effects, and so affect the nutrition of all these parts, ganglion cells, nerve trunks and nerve endings, owing to their trophic interdependence.

According to the Pflüger-Arndt law of mechanical nerve stimulation a mild irritation stimulates a nerve, a stronger irritation stimulates it still more, but a too strong stimulus lowers the nerve's activity, and a very strong stimulus causes complete cessation of activity.

It is well known that pressure upon a sensory nerve produces a sensation which by increase of pressure is increased to pain, and which lasts in different degrees until, when the pressure has reached a certain height, it becomes less, or, with still stronger pressure, disappears temporarily, sometimes (though rarely) permanently. This is a fact of practical importance, since neuralgia may sometimes be cut short in this way. By repeated blows along a sensory nerve trunk the nerve is stimulated in the same way and its activity modified or changed. In both cases, although we are ignorant of the details of what takes place, we may assume a reaction on the nerve centres other than that (especially in the case of trophic nerves) of a sensory impression. If a diseased nerve be stimulated, a weak stimulus has as strong an effect in this respect as a strong stimulus applied to a healthy nerve. But irritability is destroyed by marked morbid changes. *In practice we see that massage manipulations, especially tapôtement and that form of it called "nerve-vibrations," sometimes used in the treatment of neuralgia and other nervous affections, can relieve or sometimes cure nervous symptoms, although we are as ignorant of the way in which they act as we are of the pathology of many functional nervous diseases. I would likewise remind the reader of the generally stimulating and "exciting" influence undoubtedly exercised by nerve massage, especially tapôtement and vibrations of a certain strength.*

The activity of motor nerves is also modified by mechanical stimulation, and a reaction on the nerve centres is at least highly probable. By gentle pressure the irritability of motor nerves is increased, by strong pressure it is diminished or destroyed (Tigerstedt*). By pressure on the phrenic nerve where it can be reached in the neck it is possible to stop cramp in the diaphragm; by

* Stretching of a nerve by diminishing the lumen of Schwann's sheath, and thus causing pressure on the myelin sheath and axis cylinder, has the same effect as directly applied pressure (Zederbaum). This is important, for example, in the treatment of sciatica. Tutschek has shown that a short, gentle stretching increases, while a more repeated and stronger stretching lowers or destroys, the nerve's reflex irritability.

pressure on the spinal accessory nerve, cramp in that region; and the heart-beat may be slowed by pressure on the vagus. Vibrations have an effect like that of static pressure. Vibrations of a certain strength and frequency given on a motor nerve set the corresponding muscles in action, and can produce an effect which is many hundred times greater than the force of the stimulus.

All this is of more theoretical than practical importance, for it is rare that the masseur has the occasion to stimulate the motor nerves in this way.

Tapôtement, more than any other manipulation, can stimulate secretory nerves both directly and reflexly (probably the reflex is of more practical importance). Colombo (1895) demonstrated that shaking (but neither effleurage nor pétrissage) increases the activity of the salivary and gastric glands, of the liver, kidneys, and testicles.

But in this respect we have hitherto found massage of little use, and other means are now at our disposal of increasing gland secretion. I shall refer later, in speaking of abdominal massage, to the method of increasing a specific glandular secretion by movable pressure exercised directly over the gland cells, a method of doubtful and probably very limited efficacy.

The influence of tapôtement on the heart, pulse, vaso-motor nerves, and blood pressure will be described later on in connection with general massage. Here we may speak briefly of *Heart Massage.*

Much has been said and written on "heart massage." The point most worth mentioning is that tapôtement of the chest (chest clapping, tremble-shaking, percussion and vibration over the region of the heart) has the effect, doubtless by means of bilateral stimulation of the vagus, and probably by direct stimulation of the heart itself, of diminishing the frequency of the heart-beat (Ling, Zander, Astley, Levin, Hasebroek), strengthening the heart contractions, diminishing the heart dulness, and to some extent bringing the displaced heart-beat inwards (Heitler). Since the heart contraction and therefore the beat become stronger, the blood flow through the lungs is increased and so oxygenation is improved.

Swedish gymnasts therefore employ "chest-clapping," etc., when the pulse is rapid and irregular, and by this means it becomes slower and more regular. They also employ "chest-clapping" in emphysema and consider that the patient's dyspnœa is thereby relieved.

The method of stroking the chest internal to and below the left breast, often employed by Swedish masseuses on women patients in general massage, seems to have a quieting effect on the heart and nervous system. It is used especially in neuroses of the heart, and seems, on the whole, to be a very harmless procedure.

Professor Oertel, of Munich, introduced an absurd novelty into heart massage ("Massage d. Herzens," Munich, 1889). He begins with bilateral stroking in the axillary line at the fifth or sixth rib, strokes downwards and forwards over the sternum to the seventh or eighth rib with increasing pressure, and thinks that by this means he can produce a movable pressure on the heart as in ordinary massage. For reasons which are clear to any anatomist or physiologist, I think this statement from a professor of medicine is highly interesting, but this form of massage seems almost useless, like all that Professor Oertel has written on the physical treatment of heart disease, beyond what has for long been practised in Sweden and has been described years ago by Stokes of Dublin (see later on Terrain-cure).

I shall refer later on in this chapter, when speaking of the general effects of massage, to the influence of massage on the formation of blood, on the pulse, blood pressure, and the distribution of blood in the body.

* * * * *

Abdominal massage, as technically described in the last chapter, is an extremely valuable form of massage. It is, however, much less valuable for its effect upon the glands of the digestive apparatus and on the circulation than for its powerful influence upon the musculature of the alimentary canal.

By this influence on musculature abdominal massage or abdominal kneading produces its well-known effect on dilatation of the stomach (due to atony) and on chronic constipation, far excelling all other means of treatment.

We work upon the alimentary canal, and especially its muscular coats, by kneading it between the anterior and posterior abdominal walls in the manner already described—the manipulation most nearly resembling pétrissage.

The non-striated muscle fibres answer to mechanical manipulation almost like skeletal muscles. The former, however, are more elastic, contract more slowly and to a less extent, as well as less strongly, than the latter. N. Zuntz and Loewy in 1909 gave the shortening of striated muscle in tetanus as 60 to 80 per cent. of its resting length, that of non-striated muscle as 50 per cent. They gave the absolute force of striated muscle as 10 kgms., that of non-striated muscle as 1 to 1·4 kgms. per cubic cm. (in frogs).

In true *dilatation* of the stomach, as far as I have been able to see by careful examination, the treatment does *not* restore the organ to normal nor markedly diminish its size. But it increases its motor power and restores a certain degree of efficiency to the organ, which, at least *while massage is continued*, and by its direct help, empties

its contents into the duodenum. Under treatment by massage vomiting ceases, the body weight increases, and general nutrition improves. As soon as the treatment by massage ceases, the symptoms *generally* return, and the treatment, in severe cases, would have to be continued throughout life.

In chronic constipation due to atony in different parts of the alimentary canal, in almost all cases abdominal massage, after being used for some months, preferably twice a day, can restore the bowel to normal function. This shows to my mind that it is the strengthening of the weakened muscles which brings about their restoration, and which should be the aim of treatment. Were it only a question of direct or reflex stimulation of nerves, or of pressing the contents of the intestine onwards by manipulation, the constipation would return as soon as massage ceased.

The influence of abdominal massage on the glands of the alimentary canal is not yet fully understood, and opinions are divided on the subject. Meanwhile what is known as to its influence may help the reader to form an opinion as to what one may expect from the stimulation of gland cells.

G. Berne (1880—1890) stated that abdominal massage increased all the digestive juices, especially bile.

It is well known that nerve stimulation has a strong effect upon glandular secretion, especially in the case of the glands of the digestive tract. Every one knows the effect on the salivary glands of thinking of certain spices and foods ("the mouth waters"). The mere sight of food produces an active secretion in the dog's stomach (Bidder and Schmidt, Richet, Pawlow).

Owing to the numerous nerve elements present in the alimentary canal, it is difficult to say which of the effects of massage can be ascribed to nerve stimulation and which are due to direct stimulation of the protoplasm of the gland cells.

It is further to be noted that an inhibiting as well as an accelerating influence upon secretion may be produced by nerve stimulation. For example, under certain circumstances, by stimulation of the vagus and sciatic nerves the secretion of the pancreas can be arrested (Bernstein, Afanasiew, Pawlow).

We are at present ignorant of the effect of the quality of the stimulus upon secretion—whether, for example, mechanical stimulation of the gastric mucosa produces a gastric juice of similar composition to that produced by the presence of pieces of meat in the stomach.

On the whole the most experienced experimenters have formed the opinion that mechanical stimulation does not produce, or at least is a long way behind chemical stimulation in producing, secretion of active digestive juices. All points to the fact that the food which is to be

digested best calls forth that substance in the corresponding secretion which has the power of digesting it.

Beaumont observed the flow of gastric juice in the world-famed case of gastric fistula in his Canadian hunter when he stimulated the gastric mucosa with a feather. Thiry performed the same experiment on the intestinal mucosa in intestinal fistula. But we shall see from what follows that these experiments were useless.

Pawlow (1893) by œsophagotomy prevented the flow of saliva into the stomach of a dog, washed out the stomach through a gastric fistula, and then stimulated the mucous membrane for half an hour, first with a feather, then with a glass rod. Not a drop of gastric juice, not even a drop of water, was produced.

Pawlow showed also that lean meat and its extractives called forth a gastric juice larger in quantity but poorer in digestive power than that following on carbohydrate food, while fat delayed secretion.

The observations of Pawlow and his pupils and followers on the subject of pancreatic secretion show that it exhibits an adaptation to the nature of the food. When meat or other protein is present in the duodenum the pancreas produces a secretion containing more trypsinogen (the enzyme which digests protein); when fat is present a secretion containing more steapsin is produced (the enzyme which digests fat); when bread is present the secretion is richer in the active diastatic ferment.

As already said, it has been proved that the vagus contains fibres which inhibit secretion as well as fibres which promote secretion. The sympathetic vaso-constrictor and vaso-dilator nerves take part in this and co-operate with the secretory nerves, but the latter are of cerebral origin.

In spite of the above experiments, those who treat by physical methods are inclined to assert that mechanical stimulus, *i.e.*, massage, has the power to produce active secretion.

Colombo (1895) found no noticeable effect upon secretion after five-minutes vibration of the stomach through a gastric fistula. But after fifteen minutes of such treatment he procured a gastric juice rich in pepsin and HCl. Further vibration merely increased the watery content and thereby lowered the digestive power of the secretion.

By kneading the accessible parts of the liver Colombo produced very slight effect. But liver-*shaking* for the same time produced a marked increase of all the constituents of the bile.

(Colombo, however, found that vibration on the salivary, lachrymal, and sweat glands, as well as over the kidneys and testicles, increased their respective secretions, but chiefly, it is thought, their watery content. The secretion of the testicles was especially watery, although phosphates, salt, and spermatozoa were found in considerable quantity.)

Frumerie considers that he increased secretion of bile by massage over the liver.

Zabludowski thought that he produced an increase of gastric juice by massage over the stomach, and Gopadse thought that he had done the same. He also thought that the HCl was increased.

Gaglio, however, has shown that a string tied round the cardiac end of the œsophagus produces a more copious flow of a strongly-acid gastric juice. Mario Serena massaged a patient of fifty-five whose gastric secretion contained no HCl, although he was not suffering from pernicious anæmia or cancer, and for fifteen days he analysed the gastric secretion one and a half hours after an ordinary test meal (with meat). It remained free from HCl, although the patient gained in weight and well-being, which Serena could not ascribe with certainty to massage, since the improvement had already begun before massage. Serena performed similar experiments on three children and on some dogs, and came to the conclusion, which, however, is only a surmise, that massage alone cannot produce an active gastric secretion containing HCl in those cases in which the acid is quite absent, but that it can increase the power of acid production in those cases where it is diminished. Like other observers, he found that even if massage does not alter the gastric juice it improves the patient's well-being (probably by its influence on absorption, blood formation, etc.).

About 1880 I treated or observed under treatment by abdominal massage a number of non-cancerous patients whose gastric juice showed a diminution of HCl. I found no definite effect on the HCl content as the result of this treatment, and have not used it since in similar uncomplicated cases.

By abdominal kneading the appetite is often noticeably increased, metabolism is increased (Gopadse, Kijanowski), *and digestion takes place more quickly* (Chopoliansky).

When the large bowel is kneaded through the abdominal wall one often sees, especially at the outset of treatment, large masses of mucus cast off in defæcation.

I will refer to the influence of abdominal massage on blood pressure and the pulse-rate in dealing with the effects of general massage and in the " special " portion of this work.

* * * * *

General Massage consists of effleurage, pétrissage, and tapôtement. It comprises massage of the greater part of the extremities and of the trunk, as well as abdominal massage or abdominal kneading, which is, or *ought* to be, included in it unless any contra-indication is present. The effects produced by effleurage, pétrissage, and tapôtement, as well as by abdominal kneading, are also produced by general massage, and I refer the reader to what I have already said on the subject.

I have left to this section on general massage reference to some

of the effects of the above-mentioned forms of massage, and must now, therefore, state their effect on blood formation, the heart's action, the circulation, and especially on blood pressure and pulse-rate, as well as on metabolism and its processes.

In the first Swedish edition of this book I stated (see "Handbok i Massage," Stockholm, note on p. 269 *) that I had reason to believe that general massage was of use in *chlorosis* and *anæmia*, although I could give no definite information on the subject. The reason was that in some cases of chlorosis without any other special treatment a definite increase of the red blood corpuscles and of hæmoglobin was found after general massage, which always included an energetic and lengthy abdominal kneading. My observations were, however, few, and only allowed of a surmise. In the *Medical News*, December, 1893, Dr. J. K. Mitchell, of Philadelphia, recorded his observations on the increase of red and white corpuscles and hæmoglobin after general massage, but his cases were not quite sufficient in number to form definite conclusions. Some years later Winternitz, Strasser, and Westheimer found (by examining the finger and the ear) that all thermal and mechanical treatment, applied to the whole or the greater part of the surface of the body, with few exceptions produced an increase of the red and white corpuscles. They considered that the same effect was produced, though in a less degree, by gymnastics. In the *Deutsche Med. Wochenschrift*, 1902, No. 29, Dr. Erik Ekgren has recorded observations of nine cases of which five were treated by general massage, consisting chiefly of effleurage (? without abdominal kneading), four with only abdominal kneading. General massage or abdominal kneading in each case produced an increase of the multinuclear white blood corpuscles (with a corresponding diminution of the uninuclear elements). The increase was generally a small percentage, but often rose to two figures, in one case to 25 per cent. The blood-count was made ten minutes after the massage ceased, and the increase lasted only in exceptional cases for twenty to twenty-five minutes, and then gradually fell.† Abdominal massage, according to the tables, appears to have had a stronger effect than general massage without it.

Recently G. Rosenthal has observed that effleurage over one arm produces a marked increase in the number of white blood corpuscles within the same area of the other arm—which he himself ascribes to a change in their distribution in the blood stream. Vibration had the same effect, although not to the same extent; other forms

* The translator of the first German edition left out this note, for what reason I know not. It is therefore missing in all the foreign editions I have seen; probably in all. It is to be found on p. 269 of the Stockholm edition of 1888—1892, which came out in parts.

† The increase was probably due to temporary variations in the concentration of the blood.

of tapôtement and pétrissage had the same effect, though to a still slighter extent.

We may now state with some certainty that *general massage, and especially abdominal massage, forms a means of increasing the number of red and white corpuscles and the amount of hæmoglobin.* For my part, I find it hard to believe that the increase is only in the peripheral part of the circulation.

Most of us consider lymph partly as a transudation or secretion from the capillaries, partly as a product of metabolism in the tissues.

There is much uncertainty both in main points and in detail in regard to the formation of white, and still more so of red, blood corpuscles.

Certain of the white blood corpuscles, the lymphocytes, are probably formed in the "lymphatic reticular tissue," such as is found in the solitary follicles in the tonsils, in Peyer's patches in the alimentary canal, in the Malpighian corpuscles of the spleen, and in the histologically similar lymphatic glands. In all these parts, which consist chiefly of fine connective tissue, the lymphocytes multiply by division. According to Bizzozero and Flemming a similar tissue is found in the marrow of the long bones, in which both red and white corpuscles multiply by division. We do not know whether the thymus gland is concerned in the formation of blood corpuscles.

From these facts it is obvious that by increasing the activity of the circulation one can produce an increase of blood corpuscles by means of massage, especially by abdominal kneading, or by effleurage over the whole body.

Without committing myself to the old nervous or to the new muscular theory of the heart-beat, I would remind my readers of the nerves of the heart. These consist (1) of fibres from the sympathetic ganglia in the neck; (2) of the vagus with certain ganglia lying in the substance of the heart. The sympathetic nerves of the heart are "accelerator," and their stimulation increases the frequency and force of the heart-beat. But the vagi, which are stimulated more easily and quickly, and above all more frequently, in a reflex way than the sympathetic nerves, slow and weaken the heart-beat; strong stimulation of the vagus brings the heart to a standstill in diastole. According to Heidenhain, the vagus contains also accelerator and strengthening fibres. A sympathetic curve has many small low pulse waves; a vagus curve has fewer but larger pulse waves, with a marked difference in pressure between systole and diastole; it shows marked rise and fall.

For the rest I agree with Carl Rosenthal that by experiments with massage one finds that pressure generally rises with slowing of the pulse and falls when the beat is more frequent.

The innervation of blood vessels and facts pertaining thereto must not be lost sight of by those who wish to understand the effects of massage; its direct as well as its reflex effects must be considered.

It is scarcely necessary to remind my readers of vaso-constrictor and vaso-dilator nerves. We all remember Bernard's celebrated experiment in 1851; section of the cervical sympathetic nerves of the dog produced hyperæmia of the corresponding ear; and Brown Séquard's discovery in

1853 that stimulation of the peripheral stump caused the blood vessels to contract again. We may likewise recall how the discovery of the vaso-dilator nerves followed closely upon Bernard's experiment in 1850, in which by stimulation of the chorda tympani he produced dilatation of blood vessels and hyperæmia of the submaxillary gland; also how Vulpian by his researches on the lingual and glosso-pharyngeal nerves, and Eckhard and Lovén by their researches on the erector nerves, increased our knowledge of vaso-dilator nerves. Different investigators have since shown that both these varieties of nerves are widely spread in the body, often occurring in the same nerve trunk, stimulation of which under different conditions causes one or the other to take the upper hand, the constrictors generally predominating. Active hyperæmia may therefore be caused either by paralysis of the vaso-constrictors or by stimulation of the vaso-dilators; hyperæmia due to the latter cause always lasts little longer than the stimulation itself, while that due to paralysis of the constrictors may last a long time. On the other hand, a local anæmia is not produced by paralysis of the dilators—their section produces no contraction; in other words, they have no tonicity.

This last fact is important and has made many physiologists consider vaso-dilators as "inhibitory" nerves. One can imagine that a muscle contraction produces as a reflex, *via* the muscle's centripetal nerves, an inhibition of the centre for its own vaso-constrictors, by which inhibition the vaso-constrictors lose their tone and the blood vessels in the muscle dilate.

Lastly, one must recall that the splanchnics are the most powerful vaso-constrictors, since they control the voluminous stream in the mesenteric blood vessels, the narrowing of which is of itself sufficient to produce increase of pressure in the heart and arteries, while their dilatation produces lowering of pressure; and that the splanchnics stand in a certain reciprocal relation to the other vaso-motor nerves, which are not, for the most part, capable by themselves of exercising marked influence on blood pressure.

The vaso-motor nerves go from the spinal cord by the anterior nerve roots between the brachial and lumbar plexuses, and by rami communicantes to the sympathetic nervous system. (On the arrangement of this system see later in connection with the effect of active movements on the nerves.)

The peripheral nerve trunks therefore contain vaso-constrictor and vaso-dilator fibres. Short, gentle stimulation produces first contraction of the blood vessels with anæmia and pallor; but continued or strong stimulation, on the contrary, always produces dilatation with hyperæmia and redness. This hyperæmia, which can be produced by other means better than by massage, helps reabsorption. I do not intend to discuss here how hyperæmia promotes the absorption of chronic non-purulent inflammatory products, but that it does so is an undoubted fact. To this end we also use hot mud-baths, water or sand baths, hot air or light baths, etc. To produce hyperæmia which will promote absorption in *pannus* we cause an inflammation by the use of jequirity, and Bier has demonstrated that even the slight passive hyperæmia produced by his bandage has the same effect.

The effect of massage on the blood pressure is very variable and depends on many factors. The lack of uniformity in the numerous experiments on this question has produced a dissimilarity in results and opinions which does not exist in regard to the other effects of massage.

Our most important knowledge on this subject, as well as what is most important for the masseur to remember, is that in most cases, by a reflex effect on the vaso-motor nerves, massage can produce contraction as well as dilatation of large areas of blood vessels, and rise as well as fall of arterial pressure. On the whole rise of pressure is more usual, more noticeable, and in practice more important than lowering of pressure. The rise of pressure, which may be very considerable, is a contra-indication to massage in all cases in which hæmorrhage is likely. This contra-indication is most concerned with abdominal kneading, and is most important in cases of high degrees of arterio-sclerosis and in gastric ulcer.

Effleurage has less effect on blood pressure (see p. 42). Pétrissage and tapôtement have a greater effect, while the result of vibration or shaking over the whole body is still greater. Abdominal massage has, as already stated, a very important influence, but its effect on blood pressure is variable.

Just as variable as the effect of massage on blood pressure, but in practice of far less importance, is the effect of massage on the *frequency of the pulse*. Stimulation of the vagus, with its always perceptible retardation of the pulse, occurs much less frequently than one might suppose.

Blood pressure depends on the mass of blood, on the systolic force of the heart, on the amount of blood sent into the vessels at each systole, on the elasticity and tension of the muscular walls of the vessels, on the peripheral resistance of the arterioles, and also on the viscosity of the blood.

The most important force in raising blood pressure is *stimulation of the splanchnics and the consequent vaso-motor constriction of the voluminous mesenteric area, which is of vast importance in the regulation of blood pressure. Compression of the abdominal aorta*, which is easily brought about by abdominal kneading, causes immediate rise of blood pressure centrally from the seat of compression. Among pathological conditions which require caution in raising blood pressure, arterio-sclerosis is the commonest and the most important.

By means of Mosso's plethysmographical method, Zabludowski made experiments on the vaso-motor reflexes in massage (from one arm or leg to the other arm), and in " most cases " he found a widened, in other cases (I think possibly in all) he found a narrowed, blood stream.

Zabludowski has published a few observations on the *after-effects* of massage on arterial blood pressure in man. After massage of one arm the pressure in the radial artery of the other arm, from being 125 mm. Hg

measured by von Basch's manometer before massage, rose 10 to 12 mm. in ten to thirty minutes.

From a similar experiment described below we obtain, however, very uncertain information. Zabludowski does not say how the pressure behaved *during* massage, nor does he say what kind of massage was used on the other arm, and there is strong ground for believing that the latter factor is important.

The question would be more easily settled if the conclusions arrived at from the experiments on one kind of animal held good for another. This, however, is not the case; distinct differences are found in this respect between the dog and the rabbit,* and very probably between this animal and man. This reminds me of conclusions I drew from experimenting on rabbits,† which I mention here merely in order to call attention to the forces which *may* come into play.

After studying work on this subject I adopted the plan of performing my own experiments in such a way as to completely separate skin stimulation from muscle stimulation, and by this procedure I attained to clearer knowledge of the complicated vaso-motor reflexes. The experiment was as follows :—From the whole length of one leg of the animal the skin was removed; pure muscle stimulation (muscle-massage) was then performed on the muscles thus uncovered. Skin stimulation (skin massage) was then performed either with different manipulations on the loose piece of skin, which was still quite alive and continuous with the rest of the skin, or by light brushing (not stimulating the muscles) on other parts, *e.g.*, on the other hind leg. The blood pressure was registered in the ordinary way in the carotid.

The result obtained in all the many experiments (with about forty animals) was that pure mechanical stimulation of the skin, of whatever strength (beyond the minimum which has no influence on blood pressure), by light stroking, by vigorous kneading and pinching, always produced an immediate rise of blood pressure of fairly long duration, which later returned to its level before stimulation, with or without a preliminary fall below this level. With very prolonged stimulation this fall took place while the stimulation was going on.

In the same way all the experiments showed that pure mechanical stimulation of muscle, of whatever strength, above an insignificant ineffectual minimum, whether one carefully stroked the bared muscles or pinched them gently or firmly (= pétrissage), produced more or less immediately a temporary lowering of pressure, lasting ten to thirty seconds, which afterwards returned to its level before stimulation, with or without a preliminary rise. If the stimulation lasted more than thirty seconds the pressure returned to normal within that time.

In a mixed muscle and skin stimulation, as in ordinary massage, the result depends on which stimulus is the stronger. In a rabbit, if I grasp the muscles through the skin and subject them to kneading without stimulating the skin otherwise than by the finger tips fixed on a definite spot, I can easily obtain the lowering of pressure associated with the

* See Heidenhain and Grützner, *Pflugers Arch.*, 1877, p. 52.

† E. Kleen, "On the Influence of Mechanical Stimulation of Muscle and Skin on Arterial Blood Pressure in Rabbits." Paper read before the Swedish Medical Society, April 12th, 1887; published in *Nord. Med. Arch.*, 1888, xx. B., No. 10.

beginning of muscle stimulation. If, on the contrary, I stroke the skin (= effleurage) and so give a stronger skin stimulation over a larger area, although the muscles are stimulated at the same time, the rise of pressure due to the stimulation of the skin entirely counteracts the initial lowering due to stimulation of muscle.

Curare greatly increases the reflex irritability of the skin; in an animal poisoned by it the rise of pressure produced by a very light stimulation of the skin counteracts the lowering of pressure due to stimulation of muscle.

Chloral, on the contrary, lowers the reflex irritability of the skin; therefore with a rabbit under the influence of chloral in certain doses, one can demonstrate with great certainty the curve due to muscle stimulation, with its initial lowering of pressure, in spite of simultaneous stimulation of the skin. If the dose is sufficiently strong, stimulation of the skin alone produces a negative result.

For my part I can express no definite opinion as to the frequency of the pulse and the factors which influence it. In experiments on rabbits with skin stimulation predominating, I saw at the commencement of stimulation sometimes acceleration, sometimes slowing of the pulse, with high pulse waves depending upon a definite vagus reflex. With pure muscle stimulation, *at least* in most cases (in all those I saw), a slowing took place. Both acceleration and retardation were often followed by their opposites. I cannot agree with those (Naumann, Gopadse) who say that the strength of the stimulus is here determinative, in that a strong stimulation would produce slowing; a slight stimulation, on the contrary, acceleration. In 1888 I found that a very strong painful tapôtement of the right thigh in man produced a definite acceleration; the same result, though less marked, was produced by firm effleurage of this part, and in both experiments the acceleration was followed by definite slowing after the stimulation had ceased. In experiments on different people with rather gentle stimulation I have also noticed slowing at its commencement.

When a cannula is placed in the carotid of a dog or rabbit and connected with a manometer a *definite rise of blood pressure is seen* during abdominal kneading, chiefly due to direct and reflex stimulation of the splanchnics and consequent narrowing of the mesenteric blood stream; if the manipulations are performed strongly over the abdominal aorta, compression of the aorta acts in the same way. In these cases I never continued abdominal massage for long; several reliable observations have shown that if this is done the rise of pressure is followed by a fall. By means of sphygmographic tracings of the radial pulse in man during abdominal kneading I have seen a definite rise in the height of the pulse wave, and after five minutes' massage this effect could still be observed for an hour. During abdominal kneading the pulse sometimes becomes definitely dicrotic, tri- or tetra-crotic. One would expect by analogy from Gott's experiments on the heart-beat, and from what is often the case with rabbits, to find a slowing of the heart-beat during abdominal kneading. But in man, in the few experiments I have undertaken on this point, I have repeatedly found a definite *quickening of the pulse.* After half an hour's energetic abdominal massage the pulse-rate is often

practically unchanged ; what is most remarkable about it is that a pulse which at the beginning of the treatment was weak or almost imperceptible became quite strong. The frequency of respiration, at least in many cases, is increased.

The results of more recent experiments are as folows :—By massage of the lower extremities Eccles found the pulse-rate diminished and blood pressure increased. He found blood pressure first increased but later diminished by abdominal massage.

Edgecombe found the pressure raised by abdominal massage.

Cautru found it lowered.

Le Marinel, Lauder Brunton, and Tunnicliffe found blood pressure increased by abdominal massage in dogs and cats. The two former writers observed it fall after the treatment.

Von Bechterew and Tschigajew found shakings of the whole body constantly produce a definite rise of blood pressure in man ; the temperature at the same time fell in the axilla and rose in the rectum. Hasebrock also found increased blood pressure and diminished pulse-rate.

Romano found that abdominal massage in dogs and cats raised blood pressure and diminished the pulse-rate.

Ekgren found the blood pressure lowered by this form of massage.

Rosenthal says that general massage commonly produces a rise of blood pressure = 25 to 30 mm. Hg.

Zabludowski, Kronecker, and Stirling found that all massage in the form of effleurage, friction, and pétrissage increased the pulse-rate ; the two last mentioned found that tapôtement diminished it.

Hasebroek, Romano, Eccles, and Ekgren found the pulse-rate generally diminished.

E. Weber states that long-continued peripheral mechanical stimulation produces first dilatation, later contraction, of the cerebral blood vessels.

F. Pick showed that during effleurage over the lower extremities the blood stream was quickened in the femoral and mesenteric veins, and slowed in the jugular. In long-continued abdominal massage the blood stream in the mesenteric vessels became wider and quicker, but narrower and slower in the cerebral vessels.

Colombo performed extensive and valuable experiments on man. He found that gentle effleurage over a large area somewhat raised blood pressure ; effleurage over all four extremities simultaneously raised it as much as 20 mm. Hg. ; vibrations raised it more, especially when done on the skin. Strong effleurage and vibrations raised the blood pressure and diminished the pulse-rate. Gentle tapôtement produced a slight rise of pressure, harder tapôtement a more marked rise. Muscle massage often produced a marked rise of blood pressure up to 50 mm. Hg. General massage usually raised blood pressure as much as 30 mm. Hg. Gentle abdominal massage produced rise of pressure with diminished pulse-rate ; strong and long-continued abdominal massage lowered pressure (by 10 mm.) and increased the pulse-rate.

Metabolism is influenced by every form of massage performed over large areas of the body.

It is necessary, however, here to define the limits of what I mean by metabolism ; a disastrous confusion reigns in regard to this term. By

metabolism I mean all those molecular changes which take place within the organism in those elements which form the normal constituents of tissues. From the term metabolism I distinguish every process of digestion by means of which food in the alimentary canal is prepared for absorption by its mucous membranes, and the absorption which takes place. There is some proof that abdominal kneading has a definite influence on digestion and absorption.

One may summarise what can be said of the influence of massage on metabolism in the tissues as follows :—Muscle massage in the form of effleurage, and still more in the form of pétrissage and tapôtement, is that part of general massage which (probably mostly by local muscle contractions) chiefly affects metabolism ; this influence is shared in some degree by every form of massage performed over a large area for any considerable time. Massage involving increased activity of the digestive system causes increased nitrogenous secretion. Diuresis is increased by the increased blood pressure, and the increase in the blood of substances which irritate the kidneys.

Carbohydrate, and most probably fat also, is oxidised in greater quantities into CO_2 and water, and the total quantity of CO_2 expired is increased. Massage, however, has far less influence on metabolism than has gymnastics.

Zabludowski (1883) began a series of experiments by daily general massage, and observations before and after massage. Two of three individuals massaged lost weight and one gained. The last mentioned excreted less nitrogen compounds but more sulphates in the urine during massage than before or after ; in the two first-mentioned cases both the nitrogenous matter and sulphates in the urine were increased. The only importance of these experiments is a stimulus to further inquiry, and one can draw no conclusion from them.

Gopadse (1885) carried out four more careful experiments, each for three weeks, and embracing all the nitrogenous intake and output. He found in all four cases increase of appetite, increased power of assimilation, and increased nitrogen in the urine, *i.e.*, increased nitrogenous metabolism. One maintained, two increased, and one lost weight during massage. Gopadse's results are not quite convincing, since the increase of nitrogen in the urine was so slight (1 to 4 per cent.) that it might be connected with the improved absorption of food due to abdominal massage.

Weir-Mitchell is of opinion, although not quite certain from his experiments, that general massage produces a temporary increase of metabolism during the *séance* and noticeable for about three hours afterwards in the urine, but followed by a fall, so that the total metabolism during twenty-four hours was not considerably altered.

Keller (1889) found that general massage increased excretion of nitrogen, chlorides, sulphuric acid, and salts in the urine.

Polubinski (1889) performed various experiments on this subject the results of which are negative, but he will probably be able to come to a

more definite conclusion at some future date. Kijanowski had the same misfortune. Bum (1893) did not trouble to control the diet of his patients, and we cannot therefore draw any conclusion from his experiments.

In Bendix's careful experiments of 1894 massage was found to produce a constant increase both of the quantity of the urine and of nitrogen in the urine. This increase sometimes only began after several days' massage, but continued several days after the treatment ended. Otto Voigt (1896) obtained the same results, and he also found an increase of phosphoric acid in the urine. C. Rosenthal confirmed these results in 1908.

Finkler and Brockhaus, though their calculations were exaggerated and faulty, found that general massage of diabetic patients increased the power of oxidising sugar in the blood, *i.e.*, decreased the sugar in the urine (see later on Diabetes Mellitus).

About 1890 I stated that *abdominal massage increases the secretion of urine.*

Before that Zabludowski and Hirschberg had said that *increased secretion of urine was produced by general massage*, and the same results were arrived at by Polubinski, Bum, Le Marinel, Bendix, Voigt, and others. Bum showed that *a somewhat extensive local massage may have a diuretic effect*, by means of his experiments on the hind legs of a dog under curare, which showed a markedly increased secretion of urine.

Muscle massage and abdominal kneading increase oxidation and the expiration of CO_2 (Leber and Stüve, 1896), the increase rising to about 12 per cent. Hasebroek showed a diminished production of CO_2 by shaking and other forms of tapôtement !

Wharton-Sinclair (in Weir-Mitchell's "Fat and Blood") says that *general massage* increases the temperature of the body. Eccles (1885—1887) found that massage of the trunk and extremities increases the skin temperature but lowers it in the rectum, while abdominal massage has an opposite effect both on the skin and rectum. G. Berne (1886) also found a rise of skin temperature.

Von Bechterew and Tschigajew (1895) found shaking over the whole body lower the skin temperature but cause it to rise in the rectum.

General massage also has a very favourable effect on sleep, as on the general and psychic conditions.

* * * * *

We may thus shortly summarise this chapter :—All manipulations have to a certain extent the same effect, but each of them has a special effect. Effleurage especially helps the circulation in the blood and lymph vessels in and around the area over which it is performed, so that it raises local nutrition of the tissues, helps the healing process,

counteracts atrophy or inflammation, and is a means of promoting absorption; it also has a restorative effect after fatigue. Friction more than any other manipulation promotes retrogressive changes and absorption of inflammatory products. Pétrissage is a manipulation which also produces the same effect to a marked degree, but is also a powerful means of stimulating muscle. Tapôtement, however, of all massage manipulations, is the most powerful means of stimulating muscles, nerves, and other forms of cells, especially gland cells. Tapôtement causes local muscle contraction, even when electricity and will power are no longer able to produce muscle action. Vibration over the head affects the nerve centres; this is demonstrated by its marked effect in producing sleep in patients suffering from insomnia. Vibration on other parts of the neurons, either by direct or reflex action, produces sensory (less often motor), secretory, and vaso-motor effects of different kinds; especially does it affect the force and frequency of the heart-beat and blood pressure. Abdominal kneading is of the greatest use as a means of treating atony of the stomach and intestines and laxity of the muscular coat of the alimentary canal; it affects the glandular secretions of the alimentary canal, appetite, digestion, and absorption; it has, moreover, a powerful influence on blood pressure and the pulse, an influence, however, which varies under varying conditions. General massage comprises the above-mentioned effects of effleurage, pétrissage, tapôtement, and abdominal kneading: it increases the number of red and white corpuscles; it has a variable effect on the heart and pulse, but generally it aids circulation, increases metabolism, increases the quantity of urine, the nitrogen in the urine, the salts and the quantity of CO_2 expired; but in all these effects on metabolism massage is much less effective than gymnastics.

CHAPTER III.

CONTRA-INDICATIONS TO MASSAGE.

A CONSIDERABLE number of diseases and abdominal conditions contra-indicate or limit the use of massage when it would be otherwise indicated. There may be contra-indications to all massage, or more often to massage of an affected area.

In the first place, for massage the skin must be fairly normal, and therefore it cannot be given in several skin conditions. Unhealed recent injuries or burns, erysipelas, syphilitic skin affections of different kinds, certain forms of eczema, herpes, pemphigus, acne, boils and carbuncles, phlegmonous processes, lymphangitis, and gangrene preclude the possibility of massage within their area. Any of the above which are of an infectious and purulent nature especially contra-indicate massage in their area, since it would help to spread the infectious elements and pus and so increase the destruction of the tissues.* In many cases some manipulations may be used while others would be quite unsuitable. One can, for example, work upon an extensive scar by small deep frictions, in which that part of the scar lying under the finger tips accompanies them in their small excursions, even if it is firmly adherent to the underlying tissues. But it does not answer to apply strong effleurage, which would break the skin and cause ulcers. Deep effleurage is the manipulation which would be first excluded by anomalies in the skin, and can scarcely be used in such conditions as œdema, certain erythemata, urticaria-like wheals, small or linear ulcers, and in the pure anomalies of secretion.

Some diseases and changes in the blood-vessels contra-indicate massage in their area; others call for great caution in its use. *Aneurysms* might easily be broken by manipulation, and embolism follow. *Advanced atheroma* forbids local manipulations, which might cause detachment of particles from the inner wall of an artery and otherwise cause injury. Marked *varicosity of veins*, with or without *phleboliths*, for similar and obvious reasons does not allow any of the stronger manipulations in the immediate neighbourhood. (On the

* After acne, boil, carbuncle, erysipelas, and other processes have run their course, leaving behind inflammatory products and thickenings in the skin, massage may be used to get rid of these (see below).

other hand, cautious effleurage may be of use in many cases of chronic phlebitis and periphlebitis, with their accompanying evils; of which more anon.) Acute *phlebitis* and *periphlebitis* absolutely contra-indicate all massage in their area, since it could only provoke extension of inflammation and lead to danger of embolism from the thrombosis which frequently accompanies these troubles. *Lymphangitis*, which always depends on septic influences, likewise constitutes a "noli me tangere" for the masseur. Fresh and incompletely organised *thrombi* contra-indicate massage in and near their area on account of the danger of embolism. It is best to allow from two and a half to three months after the formation of the thrombus, so that organisation is sufficiently advanced for the thrombus to be fixed, before treatment by massage is begun.* Lastly, we must mention as contra-indications some rare diseases in which the blood vessels undergo changes not fully understood whereby severe bleeding may arise after quite mild and, in ordinary circumstances, harmless manipulations—*hæmophilia, Werlhof's morbus maculosus, scurvy, certain cases of purpura, and leukæmia.* Apart from these affections, occasionally, especially in elderly people, one meets with such a susceptibility to mechanical effects on the blood vessel walls that manipulations must be performed with very moderate strength.

Purulent processes of all kinds contra-indicate all massage in their area. This could only increase the danger of the pus spreading more widely among the tissues, with consequent rapid destruction. I know of only one exception to this contra-indication. Dentists are accustomed to order gouty, diabetic, and other patients suffering from alveolar pyorrhœa to massage their gums, with good result.

* In the beginning of my medical practice I had a painful experience of the necessity not to wage war too early against this contra-indication. The case was that of a shopkeeper about forty years of age who broke his femur at the junction of the middle and lower thirds; there was great formation of callus, and a thrombus due to compression formed in the femoral vein. *Over five weeks had passed since the thrombus first appeared*, the collateral circulation was slowly becoming established, the whole limb was much swollen with a hard œdema, the knee joint was quite stiff, movements of the ankle joint were limited, formation of connective tissue, marked atrophy of muscles, and severe and prolonged loss of function were to be feared for the future. Before treatment was begun I pointed out to the patient's doctor, an experienced surgeon, the danger of embolus, but he pointed out the comparatively safe age of the thrombus and the dangers of further postponing massage treatment. I began, therefore, with great caution, avoiding the area of the thrombus, and for a week all went well. Then, to my great alarm, several hours after a massage *séance*, the patient had a sudden pain, with shivering and fever. Immediately afterwards I found over the lower and posterior portion of the right lung a definite circumscribed dulness. I gave up massage and treated the patient for his lung condition, from which he speedily recovered, whereupon, after consultation with my colleague, treatment by massage was resumed, greatly to the benefit of the patient. I have since always waited much longer before beginning massage in such cases. It was not a particularly pleasant case for me, and I relate it as a warning to others. I got off fairly easily, but others have been unfortunate enough to cause the death of the patient by massage in the neighbourhood of a thrombus.

In malignant tumours massage over the part increases the danger of metastasis.

In (tuberculous and other) foci of infection massage in the neighbourhood may help to disseminate the poison.

Kappeler in 1890 stated that the danger is not great in the case of staphylococci.

The spread of the poison is also a danger in the case of *toxic foci* (snake-bites, stings of insects, etc.).

Foreign bodies, for obvious reasons, prevent massage in their neighbourhood.

Osteomyelitis and all cases of infective periostitis prevent all massage in their neighbourhood by their tenderness if for no other reason.

Severe general or local diseases, which necessitate complete rest for the patient, do not allow of massage; this is true, in the first place, of all *febrile diseases*.

In *acute inflammation of the kidneys* massage over a large area should be given only in exceptional cases. E. Ekgren in 1901 found the albumin in the urine increased, especially by massage of the lower extremities.

Certain *neuroses*, and especially several forms of *psychosis*, make all massage impossible on account of the patient's irritability and lack of self-control. In *high degrees of neurasthenia*, and in many debilitated conditions where there is increased sensitiveness to pain, any massage which produces pain must be either left off entirely or performed with special gentleness and consideration for the patient's sensitive condition.

Abdominal massage must be specially considered in this chapter, as many changes in the abdominal organs, besides those already mentioned, more or less strictly limit its use.

Pregnancy I consider a definite contra-indication to abdominal massage. It is certainly stated that cautious massage, even of the uterus itself, may be performed without shortening or otherwise unfavourably affecting pregnancy (Asp). For practical reasons, however, it seems best even during the early months to regard this as a contra-indication; during the later months it seems a great mistake not to do so.

Large ovarian cysts contra-indicate abdominal massage. In these cases not only is it less effective, but it may produce extreme irritation of the peritoneum, and so help to increase the usual adhesions and render operation more difficult. The possibility of sudden rupture of the cyst by incautious massage must also be thought of.

Acute inflammatory processes, either in the abdominal cavity or its

immediate neighbourhood (*peritonitis, appendicitis, salpingitis, perimetritis, liver abscess, etc.*), prevent abdominal massage, which might easily cause extension of the inflammation.

Some conditions of the kidneys, ureters, and bladder may prevent abdominal massage. In certain cases of *stone*, for example, where there has been hæmorrhage during the passage of *concretions*, in *hydronephrosis*, and similar cases, abdominal massage, for obvious reasons, is out of the question. Abdominal massage incautiously given in cases of stone in the bladder may cause (and has caused) dangerous bleeding. The same may occur with *papillomata of the bladder.*

Movable kidney is no contra-indication to abdominal massage, but should be noticed and avoided. It is a very common condition, especially in multiparæ, and can easily be recognised by any one accustomed to give abdominal massage.

Gallstones call for caution in manipulation when massage is performed near the gall-bladder. During their passage, or when they have given rise to inflammation, they contra-indicate abdominal massage.

In the presence of *echinococcus* abdominal massage increases the danger of rupture of the cyst.

In acute catarrh, ulceration, and similar conditions of the alimentary canal, abdominal massage is obviously out of the question.

In *gastric or duodenal ulcer* abdominal massage is contra-indicated, in that the accompanying stimulation might hinder healing and possibly cause hæmorrhage.

Strangulated hernia contra-indicates abdominal massage ; hernia of all kinds calls for caution.

Abdominal massage raises blood pressure often to a marked degree. It is therefore contra-indicated in *all conditions in which there is liability to hæmorrhage by rupture of blood vessels. In cases of recent hæmorrhage in the brain, lungs or alimentary canal, in cases of aneurysm, in advanced arterio-sclerosis, abdominal massage is out of the question.*

In *recent fracture* there is risk of moving the fragments in performing massage. Effleurage, which is recommended by some to produce absorption of exudation, must be performed centrally from the seat of fracture; in some cases it may be performed with great caution also over the seat of fracture. *Recent unreduced dislocations* contra-indicate massage over them, and I consider the proposal to massage in these cases (to make reduction easier) quite unwarranted. Such treatment could only cause unnecessary pain for the patient and make reduction more difficult, since it is always easier the earlier it is performed.

CHAPTER IV.

THE MEANING AND GENERAL TECHNIQUE OF MEDICAL GYMNASTICS.

*Medical Gymnastics is a therapeutic treatment by systematic exercise of the organs forming the motor apparatus of the body.** These, again, consist of *the skeletal muscles*, which by their contractions convert the chemically stored energy into that of movement or position ; of *the bones*, which act as levers for these movements ; of *the joints*, in which the movements take place round definite axes ; of *the centrifugal motor nerve-elements*, from which the motor impulses arise and are conducted ; and of *the centripetal sensory nerve elements*, upon which also the form and steadiness of the movement depend. The physiological and therapeutic effects of medical gymnastics in the first place, of course, concern these organs, but through them affect the remaining parts of the organism, so that one can justly say that no organ remains unaffected by them. Medical gymnastics is used moreover in many cases for its therapeutic effect on organs other than those of the motor apparatus.

The motor apparatus may be exercised by taking up certain definite *positions* † ; the muscle work required for this purpose is called *static muscle work*.

The positions of Swedish gymnastics were arranged and classified by our famous countryman P. H. Ling. His *starting positions* consist of *fundamental positions* and *derived positions*. There are five of Ling's fundamental positions, and a large number of derived positions. (See Arvedson's description in Chap. IX.)

But the motor apparatus is exercised also, and principally, by movements. Work which performs movement is called dynamic or motor work.

We have to thank Ling, not only for the introduction and

* The motor organs are often exercised for other than purely therapeutic reasons. Healthy persons often take *hygienic* or *dietetic gymnastics*, if their daily life without it does not supply the bodily movement so necessary for health. For these and other (preparatory) aims *educational gymnastics* are used in our schools. We also give our officers and men in the Army and Navy *military gymnastics* to increase their working efficiency.

† The Swedish gymnasts distinguish between " positions " and " holdings." By a " position " they mean a position of the body which prepares for certain movements ; by " holding," a bodily position which (for its own therapeutic value) is maintained unchanged.

arrangement of the positions of Swedish gymnastics, but also for most of the exercises and their various classifications. The most general and usually adopted and widespread of these classifications was taken by Ling from an ancient model. Since Ling's time the exercises have also been classified in other ways, especially by German doctors and authors. As the most important of these Swedish and German classifications promote a clearer insight into both the general technique and the physiological and therapeutic effects of gymnastics, I give them here.

The classification of Ling's Swedish gymnastics is as follows :—

Movements
- *passive.*
- *active.*
  - *free* (without special support).
  - *controlled* (with special support).
  - *double, duplicated, resistance*
    - *concentric* (= *shortening*).
    - *eccentric* (= *lengthening*).

Passive movements are such as are performed in the patient's joints by some outside force, represented by a person (gymnast), a weight, or a machine. By passive movements it is the joints chiefly that are exercised.

If the passive movements are given by a person he is said to be the "*giver of the movement,*" while the patient is said to "*take the movement.*" (In resistance exercises also we distinguish between the "giver" (gymnast) and the "taker" (patient) of the movement.)

For a movement to be considered as belonging to gymnastics, especially medical gymnastics, it is not necessary that it should take place by the patient's own innervation, as passive movements are also included in medical gymnastics. I am not certain (see below) that even in passive movements the patient does not often innervate the muscles which are becoming shorter. But there is no doubt that such movements *can* take place without any innervation. On the other hand, it must be remembered that gymnastics comprises only those movements which take place in the joints of the individual taking the exercise. To include those movements which take place in the joints of the operator would be as absurd as to include massage manipulations as passive gymnastic movements.

Gymnastics in its usual meaning apparently consists only of *voluntary movements.* Only the striated skeletal muscles can therefore correctly be said to be "exercised," since they alone can be said, apart from their power to produce *involuntary reflex contractions*, to contract under the influence of the *will*, which is transmitted from the ganglion cells in the cortex of the brain to the muscles by means of the nerve-end plates in

the latter. Cardiac muscle fibres are, however, striated, but are not under the power of the will; the manner of *indirectly* exercising these by bodily movements I will return to later on. The striated character of both cardiac and skeletal muscles is doubtless connected with the speed and strength of muscular contraction, and represents a high degree of contractility. The non-striated muscles in the alimentary canal, in the arteries and veins, in the uterus, etc., have slow, comparatively weak, often rhythmic contraction, are not under the control of the will, and cannot, therefore, actually be "exercised."

The characteristic movements of gymnastics are those movements which take place under the innervation of the patient's own muscles, *i.e.*, *active movements*. If these are performed by the patient without external help or support they are called *free movements*.

All movements which are performed *with the support* of some external object or apparatus are said to be *controlled* by this apparatus.*

But active movements may also be performed *with the co-operation of outside forces*, represented by a gymnast giving the movement, by a machine or weight, and are then called *resistance movements*.†

Resistance movements may be of two kinds. They may be performed so that the patient performing the movements overcomes the external resistance (of a gymnast, machine, or weight), so that the patient's working muscles become shorter. Such resistance exercises are called *concentric or shortening movements;* in them "the ends of the working muscles come nearer to their middle-points." While the muscles working concentrically become shorter, they also become thicker through the thickening of the muscle fibres and the dilatation of the blood vessels, and harder owing to the stronger stretching of the muscle between its origin and insertion (see later). But resistance movements may also be performed in such a way that the patient's muscle work is overcome by the external force, so that his muscles while working become longer. Such movements are called *eccentric or lengthening movements;* "the ends of the corresponding muscles become more distant from their mid-point." The muscle working eccentrically lengthens, but as in concentric work it becomes harder. As to the thickness of a muscle working eccentrically, I would

* Besides the apparatus which is used in almost all systems of medical gymnastics and also in Ling's system (see Arvedson's chapter), *portable apparatus* is also used, as in "stretch-stoop-stride-sitting back-raising *with a rod*" in Swedish medical gymnastics, or in Frenkel's gymnastics, when nine-pins are put up for the patient to knock down, or when he must stick pins into a board furnished with holes.

† The classification of movements in Swedish medical gymnastics is ancient. Ætius spoke of resistance movements. Of these concentric movements are sometimes called active-passive, eccentric passive-active, but these names seem to me less suitable.

here point out that in lengthening it becomes thinner, but that while performing eccentric work it is as thick as it is for the same length while doing *equally strong concentric work*, and thicker than it is when it is passively stretched to the same length. This is a natural consequence of the fact that the blood vessels and fibres of a muscle working eccentrically are for *the same work and the same length* of the same thickness as those of a muscle working concentrically. In concentric flexion the patient's flexors work and the resistance to the movement is given by the gymnast, but is overcome by the patient. In eccentric flexion the resistance is given by the patient, but the gymnast's strength overcomes that resistance and the movement is called eccentric flexion.

The importance of resistance movements is that they allow an accurate determination of the working muscles and their work. But it is obvious that in character and effects they do not differ from the analogous free active movements. If I with arms hanging down flex them at the elbow joint, this is called a free active movement; the flexors here do so much work as to overcome the resistance exercised by the weight of the forearm (plus some slight resistance which I leave out of consideration). If, instead, I take a weight in my hands or let some one resist the flexion, it becomes a resisted concentric movement, in regard to muscle work differing only from the flexion above described in that a greater amount of mechanical work is performed. If when the arm is flexed I suddenly cease all muscle innervation, the arm becomes suddenly extended by the weight of the forearm and the latter "falls"—a purely passive movement without any muscle work. But if instead of suddenly ceasing innervation of my flexors I consciously allow them to perform a little mechanical work, which is overcome by the weight of the forearm, so that the latter slowly "sinks" (the extensors not being innervated at all), it is obvious that this movement, in which the flexors are active but become lengthened, does not differ in character from a resisted eccentric movement. If I increase the extending force by grasping a weight, the movement is called a resisted eccentric movement.

In active movements, even to some extent in passive movements, it is apparent that for the maintenance of a suitable position other muscles than those which are shortening (or lengthening) come into play, although only statically. Even this "*secondary muscle work*" may have therapeutic value. In the treatment of scoliosis, for example, resistance movements in the cervical region are given (concentric head-bending backward = "concentric neck-raisings," and eccentric head-bending forward),

because in these the extensors of the spine work, and to strengthen these by static as well as by dynamic work is part of the aim of scoliosis treatment.

With regard to static, concentric, and eccentric *muscle work*, see the next chapter.

Another of Ling's methods of classification is of value to a certain extent, because it clearly shows us the relation between educational and medical gymnastics. Practically there is no system of medical gymnastics which does not contain positions and movements which also belong to educational gymnastics and the positions and movements of daily life. As is well known, these also have hygienic value. As examples I may point out that the fundamental positions of Swedish gymnastics, often only slightly, if at all changed, are found in daily life, and both in educational and medical gymnastics, and that walking is of considerable importance both in "terrain-cures" and in Frenkel's medical gymnastic treatment for ataxia.*

The classification in question is based partly on anatomical, partly on physiological grounds, and is therefore better than the purely anatomical division into trunk, head, arm, and leg movements (so-called elementary movements). It contains various *classes of movements*, of which each class contains different *groups*.

The simplest, least complicated, kinds of movements are called *fundamental movements*.

As the most important classes of these I may mention, along with Dr. Arvedson (though the following is in slightly different order)—

(1) *Introductory exercises*, (2) *Leg exercises*, (3) *Span-bendings*, (4) *Abdominal movements*, (5) *Heave movements*, (6) *Shoulder-blade movements*, (7) *Breathing exercises*, (8) *Alternate-sided trunk movements*, (9) *Equilibrium or balance exercises*, and (10) *Jumping and vaulting*.

We see at once that of these movements the first and the last (Introductory exercises and Jumping) belong really to educational gymnastics.

Introductory movements consist partly of so-called *order movements* (opening ranks, getting into line, etc.), partly of the simplest free movements.

Jumping belongs really to what the Swedish gymnasts call "*applied movements*." One may be tempted to call these *demon-*

* I want the reader to understand that, although educational gymnastics borders on medical gymnastics, it is necessary to have specially trained educational and specially trained medical gymnasts. The manufacture of orthopædic apparatus and instruments consists of steel-working, shoe-making, and tailoring, but we have special orthopædic instrument makers, and special steel-workers, shoe-makers, and tailors,

stration exercises. They generally represent proficiency in educational gymnastics and do not belong to medical gymnastics.

All the other eight classes or groups contain exercises which are done *with a definite purpose*, and are of great importance in medical gymnastics. For their effects I refer to what I shall deal with myself in the next chapter and to Dr. Arvedson's chapter. I shall only remind the reader here of the following :—

Leg movements, by dilating the vessels of the extensive circulatory area of the lower extremity, are "depletive." Like all movements, by increasing metabolism they stimulate the heart's action, the strength of which is thus increased.

Span-bendings require a large number of muscles, in particular nearly all the muscles of the trunk, but they primarily exercise the back and shoulder muscles. They straighten the dorsal spine and are of value in kyphosis and scoliosis, whilst they have this drawback, that they tend to produce lordosis.

Abdominal movements, on the contrary, correct lordosis. Swedish gymnasts consider them to be valuable for their reflex effect on the alimentary canal, causing "associated peristaltic action," and in this way influencing constipation.

Heave movements give work chiefly for the flexors of the arm and shoulder muscles, and those muscles which go from the upper arm and shoulder to the trunk ; and they expand the thorax (but impede respiratory movements).

Shoulder-blade movements are really movements of inspiration.

For *breathing* or *respiratory exercises* I refer to the next chapter and to Arvedson's chapter.

Alternate-sided trunk movements influence the mobility of the spine, besides exercising the working muscles, so that they are included in the treatment of certain deformities of the spine (see Scoliosis). Alternate side-bendings are especially effective, because they also help the circulation in the vessels of the abdomen by alternately lengthening and shortening the veins in the abdominal cavity and by compressing the liver and spleen.

Balance movements chiefly serve to exercise co-ordination of the muscles and nerves. In educational gymnastics the patient's supporting area is diminished—for example, walking along the boom ; in Frenkel's gymnastics for ataxic patients co-ordination is exercised chiefly by making use of ordinary external means of balance.

Then we have the expressions *simple* and *combined* movements, which expressions have often been incorrectly used by myself as well as by others. In order that a movement may be simple it is necessary that it shall take place round only *one* axis and in *one*

joint. Every movement taking place round *several* axes, even if these be only in one joint, is a combined movement.

But not only this. Arvedson points out, to my mind correctly, that by a "simple" movement is meant, strictly speaking, that the joint or the origin of the working muscles in this case is not fixed by the action of other muscles, but by gravity, support, or some other external arrangement.

Bodily movements may take place round various axes, but we divide these axes into *frontal* (= transverse), *sagittal*, and *vertical*.

Movements may be *slow* or *quick*, and of *equal* or *unequal speed*.

Both positions and movements may be divided according to the relation in which the halves of the body on either side of the middle line stand to each other.

In this connection we must distinguish between two different kinds of positions (or holdings) and between three different kinds of movements.

Positions (*and holdings*) *may be* (1) *symmetrical, or* (2) *asymmetrical.*

Movements may be (1) *symmetrical*, (2) *asymmetrical, and* (3) *alternate.*

A symmetrical position is one in which all analogous (= corresponding) points on both sides of the body are at the same distance from the (mesial) sagittal plane (*e.g.*, the five fundamental positions, also wing-standing, bend-standing, yard-standing, leg-forward-lying position, etc.).

In unilateral or asymmetrical positions this is not the case (*e.g.*, side-bend-standing, turn-standing, side-leg-lying, etc.).

In order to obtain the definitions of symmetrical and asymmetrical movements it is only necessary in both the above definitions to substitute the word "movement" for the word "position."

It is easy to see that for a movement to be symmetrical it is necessary that the head and trunk shall not move during the exercise round other than the transverse axis, nor in other planes than the sagittal, and that the sagittal plane of the head and trunk must throughout correspond with the sagittal (mesial) plane of the body when in the fundamental position. On the other hand, the extremities may during symmetrical movements move round any axes, if only their movements are throughout similar and performed at the same time (*e.g.*, wing-sitting trunk-bendings, trunk-raisings, backward-drawings, lying leg-adduction, etc.).

Asymmetrical movements are those in which the sagittal planes for the head and trunk do not lie in the sagittal plane of the fundamental position throughout the whole movement, or in which the

extremities of both sides do not move in similar and simultaneous movements (*e.g.*, side-bendings, rotations; among these I also include "rollings" of the trunk or head, or of the extremities of one side).

Alternate-sided movements * are those (asymmetrical) movements which arise by moving the trunk or head, or only the extremities, *alternately* first to one side and then to the other in the sagittal plane *in similar* (*though not simultaneous*) *movement* (examples of such movements we have in walking, in the "ringing" of Swedish gymnastics, in alternate rotations, etc.).

Most systems of gymnastics contain both *exercises on the spot* and *exercises with progression* (on the floor or along some apparatus, *e.g.*, the boom). Intermediate forms are to be found. For example, we have such in Frenkel's gymnastics, when the patient rotates on one heel round the long axis of the leg, while with the other leg he takes steps round a narrow circle.

In gymnastics with apparatus or machines, *e.g.*, with Zander's, Krukenberg's, or Herz's apparatus, no progression takes place, for all the exercises are kept on the spot by the apparatus.

Gymnasts use, both in educational and medical gymnastics, *a method of gradually increasing the strength of the movements* (*also called "progression"*). By this is really meant an increase in the combined muscle action in the movements, but progression may also include increased functional activity for the other organs of movement. Such progression may be made in various ways. All movements may be made more difficult by increasing their speed or their duration. In resistive movements one may increase the resistance, of whatever kind it may be, by increasing the lever arm by means of which the resistive power (or weight) works; similarly, one can diminish the patient's lever. In certain exercises one can, as may be easily seen, increase the weight of resistance to the exercise by a different position, thus producing a longer leverage for the centre of gravity in the corresponding part of the patient's own body. One may increase the resistance by changing its direction towards the force of gravity. Further, one may progress in gymnastics by making the movement more complicated. Externally the muscle action is increased by taking away the support or diminishing the supporting area, *e.g.*, by changing standing position to toe-standing; in this way one increases the work necessary for both muscles and nerves in balancing. By increasing the strength of the nervous impulses to the antagonists of the muscles used in the

* Not to be confused with "change movements." These are made use of in educational gymnastics, and are a series of symmetrical positions and movements following usually in a certain order and in unbroken sequence.

movement (in the self-resisted exercises), the work of the muscles and nerves needed for a movement is similarly increased.

In gymnastics one may *limit the muscle action* to *certain* muscles, which is principally done by the form of the movement and by external arrangements which dispense with the action of other muscles. And one may, by fixing other joints by external means, limit the movement to a particular joint. These methods of limiting the functions of muscles and joints to single muscles and joints is called in gymnastics *isolating* them.

But one hears gymnasts talk about the whole, or the outer or inner part, of the *range of movement.* The whole range of movement of a muscle is represented by the greatest possible distance between its origin and its insertion, irrespective of the length of the tendons. Biceps brachii, therefore, works in its whole range of movement when it contracts concentrically from full extension to full flexion at the elbow joint. During the movement between half-way and complete flexion it works only in the inner part of its range of movement; during movement between half-flexion and complete extension it works only in the outer part of its range of movement. In concentric " head side-flexion to the left " the scalene muscles on the left work in the inner part of their range of movement; in eccentric head side-flexion to the left the scalene muscles of the *right* side work in the outer part of their range of movement, etc. Naturally muscles may work freely, actively, concentrically, eccentrically, or statically in any part of their range of movement. By exclusive, especially by concentric work in the inner part of the range of movement lengthened muscles may be shortened; by exclusive, especially by eccentric work in the outer part of the range they may be lengthened. Both aims are attained extremely slowly and require much work (see later on Contractures).

The Germans have schemes of movements other than the one given above, which was arranged by Ling from ancient models, and which we Swedes have generally adopted. More particularly Herz has given a classification which, by reason of its freedom from rigidity, and its regard to practical considerations, seems to me to offer a sound conception of modern methods to medical gymnasts who are also doctors. Besides simple passive and active movements he distinguishes between *resistance movements,* self-resisted movements, movements exercising co-ordination, and rhythmical movements regulated and helped by pendulum or balance-wheel action.*

* The resistance movements of Herz are the same as those of Ling's system. Herz calls concentric movements active-duplicated, eccentric movements passive-duplicated, which seems to me less suitable than Ling's nomenclature above referred to.

We shall deal first with the physiological and therapeutic effects of active movements. Afterwards we shall consider what is special to passive movements and positions. Here we shall have the opportunity of considering *treatment by assisted and resisted exercises, self-resisted movements, and co-ordination movements, i.e., Frenkel's exercises,* so widely adopted since 1870 for treatment of ataxy in tabes.

Here I need therefore only mention the elaborately developed *movements regulated by pendulum or balance-wheel action,* developed so largely first by the Swedish Dr. Gustaf Zander, and afterwards by Herz, Krukenberg, and others. In these movements the nature of the movement is altered in various ways; the patient goes through every class of Ling's scheme of exercises. When the patient sets going the pendulum or balance-wheel his movement is a concentric resisted movement. After a few minutes, during which the patient neither assists nor resists the movement of the pendulum or balance-wheel, his own movement becomes active without resistance. Afterwards when he follows without resistance and is himself moved by the movement of the pendulum or balance-wheel his own movement becomes passive. During the last part of the movement it becomes an eccentric resistance movement to the extent to which the patient resists the vital force of the pendulum or balance-wheel and is overcome by it.

The movements may be performed without an external special resistance (*reine Forderungsbewegungen*), or with such resistance (*belastete Forderungsbewegungen*), but the difference between these is physiologically quite unimportant. The movements so " regulated and helped " are used chiefly in cases of joint stiffness. They are performed by means of rhythmical alternate play of antagonistic muscles, and have, of course, the effect upon the circulation associated with all muscle work, which is fully described below. As in working a " spinning-wheel," which seems to supply a model for the apparatus, they call into play chiefly the lower " sub-cortical " nerve centres and seem to have a soothing influence. For my part I consider that their chief importance lies in the fact that they exercise the joints and their corresponding muscles. For the rest the reader is referred to the study of walking for a more complete interpretation of these movements, which form an important part of Zander's so-called medico-mechanical gymnastics. Walking on level ground may be regarded as the prototype of the " unweighted," hill-climbing as the prototype of the " weighted," rhythmical movements.

CHAPTER V.

THE PHYSIOLOGICAL AND THERAPEUTIC EFFECTS OF MOVEMENTS AND GYMNASTICS.

Muscles, by which term I here denote only the fleshy part of the muscle, not the tendons, display, while living, three properties most important to our understanding of the physiology of muscle—*extensibility, elasticity, and contractility.*

By *extensibility* we must exclusively understand the power a muscle has of being drawn out, without tearing, to a greater length than it has when no power is at work drawing it out. We must clearly distinguish between extensibility and elasticity. There are many substances, *e.g.*, sealing-wax at certain temperatures, which are extensible without being elastic. Extensibility is found in both living and dead muscle. During *rigor mortis*—which is probably, though possibly only in part, the result of the coagulation of myosin—extensibility is greatly limited. But every medical student who is familiar with dissecting knows well how extensible special muscles with parallel fibres, *e.g.*, sterno-cleido-mastoid and sartorius, become after *rigor mortis* has passed off, until they fall to pieces from decay. One also finds that dead stretched muscle does not, after extension, return to its former length, but remains lengthened—*i.e.*, it has by death lost its elasticity. In order to understand our movements it is necessary to remember that the *skeletal muscles during life are extended or stretched between their origin and insertion in such a way that their extensibility to a certain extent in any position is taken into account;* in this way they are in a condition to respond *quickly*, *i.e.*, within a very small fraction of a second, to the cerebro-spinal command for movement. The surgeon, who often has occasion to observe extensibility in living muscles, knows that it is very considerably greater in young than in elderly persons, or, in other words, that the resistance of a muscle to extension diminishes with years and that muscle strains are much more common in elderly people than in the young.

Elasticity is found to any considerable extent only in living muscle, and has the same characteristics there as elsewhere, *i.e.*, the muscle returns to the form which it had lost as the result of

force. This does not only apply to change of form through stretching, but also through pressure at right angles to the long axis of the muscle as well as in other directions. The elasticity of a muscle may be diminished by infiltrations, œdema, etc. (see Myositis).

In physics the elasticity of muscle is said to be *small* because it can be drawn out and held extended by slight force, but it is called *perfect* because the extended living muscle completely recovers its former size when the extending force ceases. As in all organised bodies, the length to which it may be drawn out is not proportional to the extending force, but the more the muscle is stretched the less it is finally extended by a certain definite force. When the extension ceases a muscle exhibits an *elastic recoil*, it does not contract at once to its pre-existing length, but only by degrees.

Contractility of muscle under the influence of stimuli is a property which represents its *specific energy*, and is the means by which it is able to perform work. We must also remember that contractility in response to other irritations is also found in other protoplasmic structures than muscle, and exists even in the lowest organisms of the animal and vegetable worlds. The *myxomycetæ*, an undifferentiated, low kind of fungus, moves about by lengthening and contracting its protoplasm, and I for my part believe that it is still unproved that any cell can be found which does not in some way exhibit contraction of its protoplasm in its "continuous internal adaptation to external conditions." With regard to muscle, the non-striated muscle of internal organs as well as the striated skeletal muscles, but especially the latter, respond to stimuli by extensive contractions. But their "adequate," normal, and usual stimulus consists of a nervous impulse, and the nerves of the skeletal muscles cause them specially to contract under the influence of the *will* either voluntarily, or as a result of reflex action. To a single impulse the skeletal muscle responds with only one *twitch*, though the shortest voluntary movement always consists of at least three or four impulses. In order to contract for a longer period, *i.e.*, to be able to bring about our movements and positions, a muscle requires a series of nervous impulses, and receives at least twenty in a second. It usually does not shorten by more than half its length; in tetanus the *shortening* may be 85 per cent. of the whole muscle length. How much a contracting muscle may *increase in volume* is not, so far as I know, very definitely known.

The obvious increased hardness to palpation of a muscle while contracting, spoken of above, is not accounted for by the contraction itself, but by the increased *tension* of the muscle between its origin and insertion.

It is easy to demonstrate all these conditions upon a live rabbit, which is first put under chloroform so that all voluntary nervous influences are excluded. For example, the muscles of one of the posterior extremities are exposed; one of them is chosen and its tendon cut at the insertion without touching the muscle itself, whereupon the muscle contracts slightly as a result of having been somewhat stretched between its origin and insertion and as a result of its elasticity. The free end of the tendon is grasped in pincers, and the extensibility of the muscle is further demonstrated by gently drawing it out to a greater length; when the tendon is let go the muscle shows its elasticity by contracting to the length it had after the tendon had been cut. The chloroform is now cut off and the animal is allowed to recover. As this takes place the muscle is seen to shorten and thicken still further, even if the animal does not attempt to perform voluntary movements with it. This shortening is due to the gradually returning "tone" after the anæsthetic, through the nervous impulses which it continually receives from its motor nerve centres without any special stimulus, and which seems to be of a reflex nature.

[This tone is not only recognised by the obviously stronger tension of the muscle between its origin and insertion when waking, for tone during sleep is weakened, and under a strong narcotic is done away with. It also shows itself by a more lively metabolism in a muscle with tone ("chemical tone") than in the entirely, or almost entirely, uninnervated muscle.]

The nerve leading to the muscle is now laid bare and stimulated by an induction current. While the nerve is being prepared it often happens that the animal innervates the muscle in the attempt to move; the contraction of the muscle in voluntary innervation is then seen, the muscle usually shortening to about half its normal length. When the nerve is afterwards stimulated by a faradic current the muscle further shortens to over 80 per cent. of its length, takes up a condition of strong tonic contraction which is called *tetanus*, and hangs like a short, thick lump from its origin on the bone. One has now the opportunity of convincing oneself that the hardness of contraction in the natural position of a muscle is not a consequence of the contraction itself, but of the increased tension; the muscle, contracted to the uttermost in tetanus, feels quite soft when loosened from its insertion.

Let us now consider how the three essential physical properties of a muscle—*extensibility*, *elasticity*, and *contractility*—are shown by its functions. We have to notice first that all three properties exist, even in a muscle at rest. The muscle is, as already mentioned, stretched between its origin and insertion to an extent varying

according to the part of the body. Its elasticity therefore continually asserts itself in an attempt to contract, an attempt which, on account of gravity and other smaller forces (friction between different tissues), and of a similar attempt on the part of the antagonists, does not affect the movement in any way. But contractility also asserts itself, like extensibility and elasticity, in the muscle at rest, though to a varying extent (*e.g.*, waking or asleep). Even during sleep the muscle receives from its motor centre an unbroken series of weaker impulses amounting to a considerable number in a second. This is the cause of the tone already spoken of in certain muscles while waking, which is perceptible to palpation.

In active movements, *e.g.*, flexion of the elbow joint, the muscles which perform the movement are innervated, *i.e.*, in this case brachialis and biceps. During shortening their contraction, which depends essentially upon contractility, is helped to some extent by their elasticity. Their antagonist triceps in many cases receives an inhibiting impulse which diminishes the resistance to the exercise which its tone would give. In other cases, especially in all cases of minutely calculated movements, it is very definitely innervated and resists the flexion. Triceps thus carries out eccentric work in the actual performance of flexion. In any case, its extensibility during flexion is made use of.

So far as I know it is not yet certain what part, if any, contractility plays in passive movements. In passive flexion, *e.g.*, in the elbow joint, the extensor (triceps) is stretched, while the flexors biceps and brachialis shorten. It is obvious that, particularly in slow passive flexion, the elasticity of the flexors must play some part; they shorten as a result of this property, partly because they have previously been stretched by extension, partly because in any position of the joint they are slightly stretched between their origin and insertion. But other reasons for their shortening must also assert themselves, especially in quick flexion. Pressure transmitted from the bones moving against one another by means of the tendons in their sheaths must be considered. But one may also assume—though this has not, to my knowledge, been scientifically explained—a reflex innervation of the flexors which are about to shorten. Contractility of a muscle, when innervated, will, if this hypothesis is correct, be made use of also in passive movement. All these factors work in very various degrees according to the speed of the passive movements.

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In a work of this kind there can be no question of a detailed account of such an extensive branch of knowledge as that of the

mechanics and dynamics of movement. We must content ourselves with essentials, and must especially point out various changes in our conceptions which the last few years have produced, as a result partly of the facilities for observation which instantaneous and Röntgen photographs have given us.

Professor Otto Fischer of Leipzig has made important contributions to the question of the effect of muscle power on movements in the joints. In particular he has shown the fallacy of our tendency, in thinking of muscular contraction, to imagine either the origin or the insertion of the muscle to be fixed, and movement only of *one* bone to take place. This is true of some small muscles, *e.g.*, of the ear or eye. But with regard to most muscles, unless one of their bones is fixed by some force, *both the bones move towards each other as the muscle contracts while the angle between them diminishes.*

O. Fischer points out that if there existed a creature composed only of two parts forming levers with equal weight, which were united by means of a joint and stretched by a muscle between two points on these levers at equal distances from the joint, both parts would move similarly towards each other when the muscle contracted. If one part had less weight than the other, then the part of smaller weight would perform larger movements than the other part of greater weight.

We must further notice that when the muscle with one of its ends not fixed works no longer in one direction, but in two, it does not only produce movement in the joint over which it passes, but also in the neighbouring joints outside this area. Thus *a muscle passing over one joint works in such a manner that when it flexes the joint over which it passes in one direction it moves the neighbouring joint in the opposite direction.* Thus brachialis anticus flexes the elbow joint and at the same time extends the shoulder joint. The short head of biceps femoris (passing over one joint) does not only perform flexion (backward) in the knee joint, but at the same time flexion (forward) in the hip joint. The three vasti extend the knee joint (forward) and at the same time extend the hip joint (backward).

With regard to muscles passing over several joints the same rule may not apply, and the results vary with the positions in which the muscle contracts. Rectus femoris always extends the knee joint, and in most cases extends at the same time the hip joint. But when flexion beyond right angles takes place in the knee joint the muscle also bends the hip joint forward. And in the area of movement in which these movements take place there is an area for the knee joint in which rectus femoris has no effect upon the hip joint.

(All this of course applies when both joints are free. If the knee joint is fixed, rectus femoris always flexes the hip joint.) The long head of biceps brachii flexes the elbow joint and extends the shoulder at the same time. But when flexion in the elbow joint has reached an acute angle the long head of biceps brachii also flexes the shoulder joint.

It is obvious that if the origin of a muscle is fixed, on shortening its insertion approaches the place of origin ; if the insertion is fixed, only the position of the origin moves, and moves towards the insertion. If one lies free on a plinth and contracts rectus femoris and the other flexors, the trunk is fixed by its own weight and leg-lifting takes place. If a leather strap fixes the knees to the plinth, flexion of the hip joint takes place by raising the trunk.

If a muscle, as is the case in several instances, changes its direction at some part of its course, one must specially study its action on each side of the part where this change of direction takes place, quite independently of the muscular or tendinous structure of the corresponding part—*e.g.*, tibialis anticus above and below the anterior ligament, biceps and brachialis above and below the place where they are bent over the cylindrical joint of the humerus.

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To understand correctly the whole of our motor life it is important to remember the influence we are always subject to through the *force of gravity* working towards the earth's mid-point, and the *friction* against our supporting surface resulting from this force, without which the erect position in particular would be difficult to maintain.

The form and direction of our movements also depend upon both the osseous and soft parts of the joints, *i.e.*, upon the shape of at least two extremities of bone, and the shape of both the capsule and the strengthening ligaments ; further, upon the co-operation and direction of the working muscles. Upon all these factors and upon the innervation, with regard to voluntary movement, depends the *magnitude of its excursion or range.* The *power of the movement* depends upon many different factors to which I shall return in more detail below. Here I will only point out that *the speed of a movement* and its *power* are very often directly connected with each other, but that this is not necessarily always the case. A slow movement *may* be done much more powerfully than a similar quick one, *e.g.*, in the " self-resisted " movements.

By the expression " *measurement of a movement* " Swedish gymnasts are accustomed to denote the amount of work which is thereby performed. This work depends primarily upon four points—upon the weight or mass moved, upon the range of move-

ment, upon the direction of the path of movement in respect to gravity, and upon the duration of the movement.

The physiological and therapeutic effects very often *appear* by degrees and indirectly. But they *arise* always to a certain extent immediately. What does not take place after or as a result of ten muscular contractions will not follow ten thousand contractions. But the effects depend to a large extent for their appearance upon the degree of muscle work and upon the amount of products of combustion formed. We see in this, as in other cases, that if small doses in general excite and stimulate, large doses often depress and weaken, and are often followed by a quite opposite effect. When the muscles actively contract or thicken, there arise at once certain effects upon the circulation. Similarly, the production of materials which cause fatigue begins immediately. While these " fatigue products " are circulated in quite small quantities in the blood, they do not produce fatigue, and probably are in part the reason why a short spell of physical exercise has a decidedly stimulating effect. The peculiar sensation, painful when intense, and the functional disturbances of which fatigue consists, appear first after more or less excessive muscular work. After moderate exercise for a long time the hypertrophy due to work develops by degrees in the muscles; after continued excessive exercise we sometimes see muscle atrophy as the result of over-strain.

On the whole one may express the opinion with regard to the therapeutic effects of medical gymnastics, as of massage, that they are generally beneficial, but are generally also slowly obtained.

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Active movements are the most important part of medical gymnastics.

Before we enter further into a description of their many physiological and therapeutic effects we may obtain a good epitome of much of their physiology and pathology by specially considering the *most important conditions which determine the strength of the movement.*

The strength of our voluntary active movements is determined, as already said, to an important degree by *the number and strength of the nerve impulses from the motor centres which make up the normal muscle stimulus.* Again, it is the *will* which in this case decides both the strength of the impulses and their number, and which with wonderful precision and certainty deals out its commands for all our movements, from the weakest to those which represent our greatest effort.

With regard to the *maximum exertion of force*, we are, however, largely dependent on our *accidental general condition*, our " *disposi-*

tion," which is an expression of psychic and somatic influences of various kinds (joy, anger, fear, dejection, sleep, waking, meal-times, etc.) and on the chance functional capacity of our various organs.

In our physiological laboratories we stimulate muscle by chemical, thermal, mechanical, and electrical means, but generally by electrical, and preferably by the faradic current, if we wish to study other than single muscle twitchings. It is the opening or closing of the current, the *change*, which produces contraction. With one stimulus we obtain only *one* twitch (after a " latent period " of at most $\frac{1}{100}$ second after the stimulus reaches the muscle); by means of a series of such stimuli we get longer contractions, *i.e.*, movements; with stimuli following closely upon one another we obtain strong, continuous cramp called tetanus, which is more easily produced, and by weaker stimuli, in a tired than in a rested muscle. We stimulate the muscle either indirectly by allowing the current to pass through its motor nerve, or directly by letting it pass through the muscle.

It has been found that *irritability is different in different muscles*—different, for example, in the flexors and extensors; the former are usually more irritable, and respond to a stimulus which is too weak to produce a contraction of the extensors.

Different muscles contract in response to the same stimulus with different strength and speed, according to slight differences of histological structure without regard to their sectional area. *The poorer a striated muscle is in the inter-fibrous homogeneous mass called " sarcoplasm," and consequently the richer it is in striated muscle fibres, the quicker, and I suppose the stronger, is its contraction, all other things being equal.*

As for the weakening influence of the *fatigued motor nerve* itself, we may say that in all probability it is to be looked for in the ganglion cells, and in the end plates, but not in the nerve fibres. By stimulating a motor nerve (by means of an induction current) one can keep the corresponding muscle in tetanus for hours. But as soon as the stimulus passes through a ganglion cell—as, for example, in the case when reflex movement is produced by stimulation of a sensory nerve—one notices, after the stimulation has continued some time, distinct symptoms of nerve fatigue, which, as we remarked in passing, must be distinguished from fatigue of the muscle itself (see below).

Central or peripheral changes of pathological nature in the neurons which have to do with our movements (whether these neurons are motor or sensory) bring about various changes in our movements, and may cause involuntary movements and abnormally weak or exhausted motor power, just as they may produce abnormally strong or in other ways disturbed movements.

Thus we see pareses and paralysis arise as the result of tumours or of cerebral or spinal hæmorrhage, hysteria, acute anterior polio-

myelitis, and certain poisonings, traumata, etc. In meningitis, hysteria, epilepsy, spastic diseases of the spinal cord, tetanus infections, hydrophobia, strychnine poisoning, etc., we see tonic or clonic cramp. In tetanus the muscles may contract with such force that, *e.g.*, sterno-cleido-mastoid wrenches the clavicle from its articulation with the sternum. In traumatic or rheumatic or degenerative processes in the peripheral nerves we have similar motor symptoms—sometimes hypertonic, usually hypotonic. If the sensory nerve elements (see below), on which to a certain extent our movements depend, are injured, various motor symptoms are apt to arise.

If, for example, the posterior roots of the peripheral nerves, which only contain sensory fibres, are cut in a mammal, extensive functional motor disturbances arise, with symptoms which are purely paralytic. In certain nervous diseases, especially tabes, disturbances of co-ordination arise * ; the movements become swaying and uncertain in form and consequently weaker in strength.

The strength of our movements, other things being equal, depends to a certain extent on the thickness of our muscles, or rather of the muscle fibres. Measurement is easy only on muscles with parallel fibres, which fibres are usually (by the way) 3 to 4 cm. long, but may be even 12 cm. In measuring, the section must always be made at right angles to the muscle fibres, and examination is consequently more difficult in muscles with diagonal, *e.g.*, with penniform, fibres. Henke reckoned that a muscle at the beginning of its contraction is able to lift 7 to 8 kg. per square cm. of its sectional area ; others have given the larger number of 10 kg. A muscle which has become atrophied owing to a bandage, inactivity, or lack of nourishment for one reason or another, is therefore, other things being equal, necessarily weaker than a normally thick muscle.

But the power of a muscle does not only depend upon the quantity of its protoplasm, but also on its quality. I have already mentioned the difference in power, even within normal limits, between different muscles according to their richness in fibre or sarcoplasm. Degenerative and inflammatory changes in muscles of all kinds weaken them. Fatty degeneration, granular albuminoid degeneration (" Trübeschwellung "), myomalacia often greatly lower the strength of muscles. Acute and chronic myositis have the same effect, the former more particularly by tension in the tissues and pain, the latter frequently also by increasing the interstitial con-

* Co-ordination is understood most easily by the student, according to my experience, if it is defined as the correct relation during movement between the different parts of the nervous system innervating the working muscles.

nective tissue and its encroachment upon the fibres. Alcoholism and senility are common causes of muscular weakness.

According to Schwann's law, a muscle contracts more forcibly the less it is previously contracted. The flexors of the arm, for example, are strongest at the point of maximum extension, weakest at extreme flexion. It is worth noting that a muscle is not at its maximum strength during that part of its contraction in which it is using up the greatest amount of oxygen and producing most CO_2, namely, during the greatest shortening. The blood vessels of the muscle are also fully distended during its greatest shortening.

The strength of the muscular contraction diminishes markedly to the extent the muscle tires. Muscular fatigue is recognised by

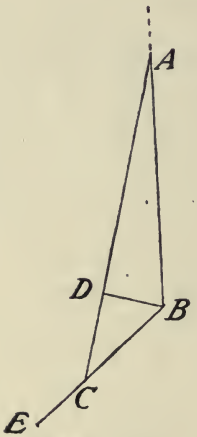

FIG. 29.

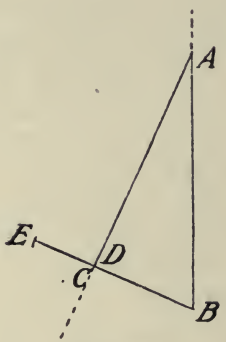

FIG. 30.

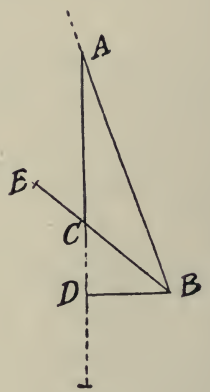

FIG. 31.

weaker contractions, and at the maximum degree of fatigue voluntary impulses cease to be able to produce any contraction whatever (see pp. 45 and 85, and further on *re* Strain).

The actual length of the lever arm is of great importance in turning the strength of our movements fully to account. This length is represented by the line drawn from the fulcrum of the joint (round which the movement takes place) perpendicular to the axis of the muscle, i.e., to the line representing its direction.

We must clearly distinguish between the true or actual physiological lever, which changes its length during the different stages of the movement, and the constant anatomical lever which is made up of that portion of the bone in question between the fulcrum or axis of rotation within the joint and the insertion of the muscle on the same bone.

The true lever varies in length during the different stages of the

same movement, and changes in different ways in different joints. In "neck-raising" or bending of the neck backwards, for example, the true lever is least at the beginning of the movement and greatest at its close. In flexion of the elbow joint (from full extension) the true lever is least at the beginning of the movement, reaches its maximum when the movement has gone almost to a right angle and thence to a rather wide acute angle, in which the flexors meet the bones of the forearm perpendicularly, and it diminishes again afterwards.

Figs. 29, 30, and 31 show changes in the length of the physiological lever BD, while the anatomical lever BC of the bone BE is bent by the muscle AC towards the fixed bone AB. BD is greatest in Fig. 30 where it is equal to and coincides with BC, but smaller than BC in both Fig. 29 and Fig. 31.

The movement of a force about a point is measured by the product of the force and the length of the true lever; it constitutes an important point in deciding the strength of the movement.

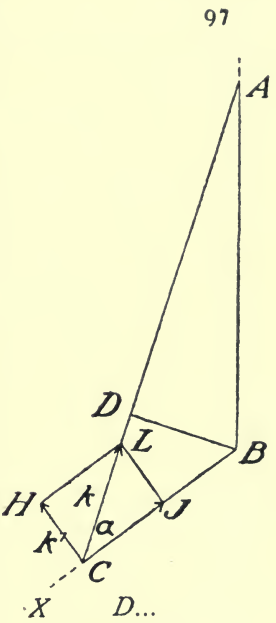

FIG. 32.

In order to examine critically the moment of a rotary force (M_α) I make use of Fig. 32. AB is the fixed bone and BX the bone moving round its axis in the joint B, part of which, BC, is the anatomical lever for the muscle AC, whose physiological or true lever is represented by the straight line BD drawn from the fulcrum in joint B perpendicular to the line of action of the muscle AC. The force acting at C in the direction CA is represented by the portion CL of the line CA. The parallelogram, which in this case is rectangular, is drawn upon CL. The two components are CJ and CH. One of these, CJ, presses upon the joint B, but does not produce any movement; the other, CH, works with all its force upon the anatomical lever BC, causing rotation in B (in the direction of the tangent, with B as centre and BC as radius).

I may now *either* give the moment of the rotatory force (M_α) as the product of the anatomical lever BC and the force CH working perpendicularly to it, which force I may call K′.

$$M_\alpha = BC \cdot K';$$

or I may give M_α as the product of the whole muscle force CL, which I call K and the true lever BD:

$$M = BD \cdot K.$$

That both products are the same is obvious; for $K' = JL$. The

triangles BCD and LCJ are similar, because the angle DCB (α) is common to both and the angles BDC and LJC are right angles, and the other angles CLJ and DBC are therefore equal. We may therefore make up the equations

$$BC : BD = LC : LJ = K : K',$$

and therefore

$$BC \cdot K' = BD \cdot K.$$

For our examination the following equation is most suitable :

$$M_\alpha = BC \cdot K'.$$

Into this we may introduce

$$K' = K \cdot \sin \alpha,$$

and we get

$$M_\alpha = BC \cdot K \sin \alpha.$$

As both BC and K are constant, the changes of M_α depend upon changes of sin α.

If AB and BC were in a straight line with one another, AC would coincide with this line, sin α would $= 0$, and therefore also $M_\alpha = 0$. Sin α reaches its highest value, which is 1, when $\alpha = 90°$.

$$M_{90} = BC \cdot K.$$

The greatest moment of rotation, *e.g.*, in flexion of the forearm, is reached, as we see from the above, when the bones of the forearm stand at right angles to the flexors.

In stronger flexion α increases and M_α diminishes. If α became $= 180°$, or in other words if AC coincided with AB, we should again reach the minimum, and the moment of rotation would become $= 0$.

But with regard to movements in joints, flexion, as we all know, is never so complete but that the muscle retains a considerable leverage. In complete extension, when the upper and forearm are in a straight line with each other, the muscles (the axis of which we here call AC) have still some leverage left, because they change their direction as they lie close to the cylindrical joint surface of the humerus, and in full extension meet the forearm at an angle, although a very acute angle.

During the last degree of flexion the power of the muscles diminishes strongly, both on account of Schwann's law and of the shortening of the true lever.

It is obvious that many pathological changes in both the osseous and soft parts of the joints influence the strength of our movements to a considerable extent (see Diseases of Joints).

The momenta referred to above cannot by themselves give us an adequate understanding of the force with which movements in the different joints take place. Even normally the differently constructed joint surfaces, the different canals for the tendons, and the different amount of resistance to the movements offered by the joint capsules in different positions play some part (A. Fick). Herz has made diagrams for each separate joint showing how the force changes in different positions. By diagrams one can estimate the strength of each muscle group and, by taking the powerful quadriceps femoris as 100, obtain the relative value of the specific

energy of every group. These diagrams, which are of value chiefly for constructors of gymnastic machines, show that if certain movements have their greatest strength during their first part, there are others which are weakest at the beginning, and that the force may either first increase and then diminish, or it may do the opposite.

* * * * *

Our motor apparatus is constructed, owing to the short leverage of the muscles (especially in the extremities, but also on the trunk), more for quick than for strong movements. If, as an example, we still consider the elbow joint, it is obvious that biceps brachii and brachialis anticus, on account of their very short levers, need only contract very little in order to bring the arm from full extension to, *e.g.*, flexion to a right angle, and that their insertions need only move a very little way in comparison with the distance which the hand has to move at the same time. The weight lever in the hand changes considerably like the physiological lever of the muscles on the bones, but in certain positions it is comparatively very great. When with the forearm horizontal I hold a weight in the hand with the elbow flexed to a right angle, and the products of the weight and length of the lever on either side are equal and therefore in complete equilibrium, it is obvious that in order to maintain the position I must exert considerable muscular force in comparison with the weight.

* * * * *

The study of the effects of muscle action, especially in active movements, upon the muscles themselves, the bones, joints, and nerves connected with the motor apparatus (both motor and sensory), upon the circulation, respiration, metabolism, and other functions, disposes entirely of the not uncommon idea among people ignorant of physiology that the muscles are of little other use than as organs of movement.

* * * * *

Julius Wolff has pointed out the importance of active movements *for the development and architecture of the whole skeleton, and has demonstrated that the shape of the bones, which aims at fulfilling the mechanical requirements with the smallest possible bulk, partly depends upon the tension of the muscles on them.*

Further details concerning the effect of muscle movements on the nutrient arteries of bone have not, to my knowledge, been investigated. *But all points to the fact that muscle work, by the increase in blood pressure and rate of blood flow thereby produced in the muscles, does not diminish the flow in the nutrient arteries of the*

bone, but, on the contrary, produces an increased flow of blood through them, whereby the nutritive condition of the bones is improved. The fact that paralyses are followed by atrophic changes also in the bones supports this theory.

* * * * *

Joints are exercised in their functions and maintained in good nutrition by both active and passive movements. Hygienically, active movements are of more importance in this respect, and keep the joints in better nutrition than other movements. *But in the gymnastic treatment of diseases of joints passive movements are of most value.* In diseases of joints which ought to be treated by medical gymnastics the object is usually to stretch contracted parts. For this purpose passive are more useful than active movements, since the latter are usually performed too feebly, partly on account of muscle atrophy ; partly on account of changes in the joints, especially in the soft parts ; partly also owing to the pain associated with the movements.

* * * * *

Muscle action strongly affects the circulation in various ways.

The first phenomenon which arises is the *dilatation of the small vessels of the working muscles*, the arterioles and capillaries. Acceleration of the heart beat and rise of blood pressure also occur. These phenomena produce a blood stream three to five * times as great during moderate work, seven to ten times as great during hard work as in a muscle at rest.

With a stronger blood stream there follows always a stronger lymph stream.

An immediate result of the greater supply of nourishment in the stronger blood stream to the working muscle is *the improved nutrition of the muscle. By repeated, systematic work, continued for a sufficiently long time, the muscle thus undergoes a "progressive change" in that its fibres increase in thickness. Thus by means of gymnastics an atrophied muscle may regain its normal thickness ;* a normal muscle may become thicker and reach that nutritive condition called "*work-hypertrophy.*" Obviously all this can only be due to the increased blood stream, brought to the working muscle by the dilatation of its own blood vessels, not only bringing a sufficient quantity of fuel and oxygen for the increased combustion, but also leaving a surplus amount of nutritive material, especially of nitrogenous substances, which is stored up in the form of muscle protoplasm.

* *E.g.*, the blood in the levator labii of a horse represented 17·5 per cent. during rest, 85 per cent. during work, of the whole weight of the muscle.

However, in extreme, continually repeated over-strain it may happen that the dilated vessels are not able to bring to the muscle sufficient nutrition to cover the expenditure, and it thus happens in rare cases, that *long, repeated, excessive, muscle work produces atrophy in the over-strained muscles* (see below).

But with continual and superfluous rest, *i.e.*, insufficient work, the nutritive condition of the muscle always sinks, and we all recognise as the opposite of work-hypertrophy the *atrophy of disuse* found in paralysis, joint diseases, and other conditions where there is insufficient muscular activity.

The repleting and depleting effects of gymnastics are based upon the increased supply of blood to the working muscles. Both these effects are obviously important. When in a closed vascular system containing a certain quantity of blood (about 4 litres in an adult) a certain part receives a greater supply than before, another part or parts must receive a less supply than before; in the latter area either the path of the stream must become narrower, or the stream itself slower, or both these changes take place. We all know what effect the mesenteric vessels, with their powerful, continually changing stream, exercise upon the distribution of blood, as upon blood pressure. We also know that there is no better cure for hyperæmia of the head than to take a brisk walk, which by the enormous dilatation of the stream in the lower extremities depletes the upper parts of the body.

But as soon as we enter into further details in these cases, and especially as soon as the question affects the neighbouring areas, we find it difficult to form certain and definite ideas. We know too little of the dimensions of the various areas of vaso-motor innervation, quite too little about the different reflexes which affect the nerves of the blood vessels, and are often in doubt whether a movement acts as repleting to or depleting from a certain region. With regard to the important question of the effects of movements upon the distribution of blood in the organs of the pelvis particularly, we should be very careful in our decisions. We scarcely dare to express the opinion that a walk diminishes the quantity of blood in the pelvic organs, which we consider a certainty because the *additional supply* of blood flowing through the external iliac artery during the walk is greater than the *additional supply* in the common iliac artery, and therefore the stream in the hypogastric artery must diminish.

More detailed decisions than these are, for the present, quite unwarranted.

The Swedish gymnasts have for the most part followed Thure Brandt in their definite ideas on the effects of certain gymnastic movements upon

the distribution of blood in the pelvis, especially in the sexual organs. His idea may be thus stated, that work for ilio-psoas brings blood *to*, work for the glutei takes blood *from*, the genital organs. The much used resistance exercises " knee-updrawing " and " knee-downpressing " are considered to take blood to, " crook-half-lying knee-parting and inpressing," with or without pelvis-lifting, is said to take blood from, the uterus. If one remembers that the ilio-lumbar artery goes from the posterior ramus or from the main trunk of the hypogastric artery, and that the superior gluteal branch is the termination of the superior ramus of the hypogastric artery, a troublesome doubt arises as to the real connection of these things. To a philosophic mind it is good to know that this troublesome doubt never troubled either the renowned Major Brandt, who quickly but decidedly formed his ideas on clinical grounds, or other gymnasts who usually form fixed opinions in quite inscrutable ways.

But muscle work in many other ways exercises a far-reaching influence on the circulation.

The thickening of the muscle during its contraction, which is produced partly by the thickening of the muscle fibres, partly by the dilatation of the small vessels in the muscle, compresses the easily-yielding veins, both the deep veins lying between synergistic muscles and the superficial veins between the muscles and fascia, and by this means empties their blood on towards the heart, its return towards the periphery being prevented by the valves. In the same way the lengthening and thinning of the muscles following their contraction and thickening must produce an expanding effect on the compressed veins. These effects are strongest where they are most necessary. It is obvious that in the lower extremities, where the muscles correspond to 56 per cent. of the whole muscle mass of the body, the venous blood-flow must be strongly influenced by the thickening and thinning of the muscles, by which the column of blood is now squeezed, now sucked, onwards. *This effect produced by the muscles is an important item in the mechanical series which nature has prepared to force the blood onward to the right auricle, and is a necessary part of it, working in combination with the valves of the veins, with what remains of the systolic force, either direct or due to the elasticity of the arterial walls, with the stretching of the fasciæ, with the enlargement of the capacity of the veins by their expansion and its diminution by their compression during movements, with the elastic force of the lungs, especially during inspiration, and lastly with the increased pressure produced by the contraction and lowering of the diaphragm on the hepatic, splenic, and other abdominal blood vessels.*

In this little reminder of the forces which assist in bringing the venous blood back to the right heart it should not be wide of the mark to draw attention to the fact that *suction due to active muscular diastole does not take place in all the chambers of the heart.* On the whole we can best

understand the physiology of the auricles if we consider them as an expanded termination of the respective veins, and their diastole as the effect of the negative pressure which obtains in the thorax outside them, and only to a slight extent of their own elasticity. The diastole of the ventricles arises from analogous reasons ; their elasticity, however, has a stronger effect. By their diastole a decided suction is exercised on the blood.

The stretching of fascia, with its influence on the circulation, is a muscular effect and must be here considered somewhat in detail, although a clear idea of these effects can only be obtained in the dissecting-room. It was Braune who showed in 1871, although the idea had already been expressed by Hyrtl, *that the fasciæ, along with the bones and muscles, form an apparatus which has a suction and pressure effect on the blood in the veins, working towards the centre.* This apparatus varies much in its construction, but speaking generally the veins lie partly in spaces which are limited by bones and muscles and on the outer side by fascia, and which vary in volume, the space being larger when the fasciæ become tense by muscular action and overcome the atmospheric pressure, but smaller when the fasciæ relax and the atmospheric pressure forces them in towards the corresponding part of the body. When the fasciæ become tense the somewhat flattened veins become wider, partly and chiefly owing to the negative pressure outside them due to the expansion, also owing to their being bound to the fasciæ by connective tissue. The blood is therefore sucked towards the expanded portion of the vein from the adjoining peripheral part of the vein. When thereafter the fascia is relaxed in the corresponding movement and is pressed inwards by the atmospheric pressure, the expanded and hitherto somewhat cylindrical portion of vein is pressed flat and the blood is squeezed out of the region, its direction being assumed by the valves of the veins.

Such *venous pumps* are found in many places—in the thigh, popliteal space and lower leg, in the arm, forearm and hand, near the lower jaw, clavicle, etc.

The femoral vein is affected as above described throughout its whole length. In its lower part sartorius and a fibrous membrane from adductors longus and magnus to vastus internus lie over the vessel, which is widened when the membrane becomes tense on contraction of sartorius.

Higher up a fascia with a free upper border goes from sartorius at the saphenous opening to the pectineal fascia ; here the falciform process is attached to Poupart's ligament. Beyond the saphenous opening the vein is therefore covered by a membrane which is lifted when sartorius contracts. Where the femoral vein enters the external iliac vein the vessel is covered by Poupart's ligament ; the femoral vein is here connected by its funnel-shaped sheath (of Linhart) to Poupart's and Gim-

bernat's ligaments. Both the upper part of the femoral vein and the lower part of the external iliac vein therefore become widened when Poupart's ligament becomes tense, *i.e.*, when the oblique muscles of the abdomen contract, or in outward rotation of the thigh or extension of the hip joint. In the same way one finds in these movements that the femoral vein below this area is emptied of blood. The same portion of the vein, on the other hand, becomes well filled with blood when the thigh is rotated inwards and flexed at the hip joint.

Just in the region where his arrangement acts the femoral vein receives a large supply of blood from different areas through the great saphenous, the external superficial, and deep pudic, the superficial epigastric, the superficial circumflex iliac, the deep inferior epigastric, the internal and external circumflex, deep femoral and pubic veins, and venæ comites—a list which gives the reader some idea of the special influence of walking on the circulation of the lower extremities and adjoining regions.

In the popliteal space the mechanism is easily seen, the vein lying in the space which is bounded in front by the joint, at the sides by biceps, semi-membranosus, semi-tendinosus, and both heads of gastrocnemius, behind by fascia. This becomes tense on slight flexion of the knee joint, and by enlarging the space widens the vein, but on full flexion of the knee joint it becomes relaxed, so that the atmospheric pressure from without presses the fascia in towards the above-mentioned space and presses together the walls of the vein, which is thus filled and emptied by the same movement.

In the axilla the arrangement of fascia between pectoralis major on one side and latissimus dorsi and teres major on the other acts with the muscles in the way above described on the axillary vein, now filling, now emptying it; this helps the smaller tributary veins.

The axillary vein lies between pectoralis minor and the scaleni, in a space which by enlarging and diminishing has an effect on the circulation.

At the large venous angle in the lower part of the neck, into which both veins and the larger lymphatics open, sterno-cleido-mastoid, which is almost always more or less contracted, holds the jugular vein well open. The middle layer of cervical fascia, lying under the muscle, is attached below to the sternum and clavicle, and above to omohyoid. The contraction of omohyoid therefore also holds the jugular vein open. But when the shoulder is lowered and the head at the same time is turned towards the other shoulder, omohyoid has a compressing effect on the vein.

In the neck platysma lifts the skin over the veins, and thus has a widening effect on them.

In active as in passive movements the blood vessels are stretched, especially the veins, and thus increase their capacity, in spite of becoming at the same time rather compressed, so that the amount of blood in the stretched area is increased. When during movement in the opposite direction the vessels are again shortened, part of their contents is pressed on towards the heart. The powerful inferior vena cava especially undergoes very considerable alterations in its size during movements in the lumbar region. Accord-

ing to this law the pulmonary vessels contain more during inspiration, less again during expiration, and the respiratory movements in this way considerably assist pulmonary circulation.

There is reason to suppose that *movements in the lumbar region*, Trunk-rolling, Side-flexions, Trunk-forward-bendings, etc., *have to some extent the power of compressing the abdominal organs, especially the liver and spleen, from which the blood is to some extent squeezed out like water out of a sponge, thus increasing the stream in the inferior vena cava.*

Muscle work causes stronger heart-beats and increases their rate. To a small extent this is the result of the effect upon the venous flow already referred to, and increases the supply of blood to the heart. But *it is chiefly on account of the presence in the blood of metabolic products, which arise during muscle action, and which stimulate both the heart muscle itself and the nerve centres which regulate cardiac activity. A reflex effect from the tissues thirsting for oxygen and nourishment was formerly thought to be the cause, but is now denied. During muscle action the heart dilates more strongly in diastole, contracts more forcibly in systole, with each beat forces a greater quantity of blood into the aorta, and performs this more times in a minute than while resting.*

Respiration has a strong influence upon circulation, and he who wishes to demonstrate the physiological and therapeutic effects of physical exercise will do well to consider this influence in connection with the description of the circulation.

Physical exercise works strongly upon the circulation, in that it gives rise to substances in the blood which excite the respiratory centre in the floor of the fourth ventricle and in this way cause deeper and more frequent respirations.

We now assume on good grounds that there is a direct stimulation of the respiratory as of the cardiac nerve centres, caused by the above-mentioned substances, and have discarded the former explanation of reflex stimulation from the tissues thirsting for oxygen, and from local dyspnœa.

It has already been shown that deeper and more frequent respirations in this way accelerate pulmonary circulation, and that the pulmonary vessels are lengthened and receive more blood during inspiration, but during expiration become shorter and contain less blood.

I must also mention in this connection the fact, so difficult for those with little knowledge of physiology to understand, that *deep inspirations strongly affect the circulation, because the lungs, owing to their elasticity, try to contract more strongly the more they are enlarged by inspiration, and, by means of this stronger effort, further lower the pressure in the thorax, which was already negative.*

As every student of physiology knows, the lungs are developed in the thorax in such a manner that their elasticity is always taken into consideration; in other words, if the thorax is opened from outside, so that the atmospheric pressure is as great on the external pleural surface of the lungs as that on the inside through the air passages, the lungs will contract. Owing to this elastic attempt to contract continually counteracted by the atmospheric pressure through the air passages, *there exists in the thorax outside the lungs—except during very quick expiration and strain—always a negative pressure*, which in normal position of expiration only reaches a few (— 5 or — 6) millimetres mercury, but during a strong inspiration, when the lungs, being expanded to the utmost, attempt to contract with their maximum force, sinks to even — 30 mm. of mercury (below atmospheric pressure).*

Deep inspirations favour the diastolic movements of the heart by the strong negative pressure outside it in the thorax, and deep expirations assist the systolic movements, though indirectly, by continually diminishing this negative pressure. *During deeper respirations the heart therefore works more strongly—alternately as a suction and as a pressure pump.*

By their influence on respiration active movements work also upon the circulation by causing *the movements of the diaphragm to become stronger, deeper, and more frequent.* When the dome of the diaphragm from being arched up into the thorax is lowered by its contraction, the pressure in the abdominal cavity is raised and the blood is more strongly forced from the abdominal vessels than during rest, but probably only with moderate force (Hasse, Walz).

K. Walz has called this influence of forced inspiration upon the liver "liver-massage." He found (1901) that circulation in the liver and the emptying of the gall-bladder was promoted in this way.

Blood pressure, which depends on many circumstances (see p. 58), but to a marked degree on the strength of the heart's action and on the resistance in the arterioles, *is affected in many different ways by physical exercise.* By the dilatation of the vessels in the muscles during work pressure naturally sinks in these vessels and centrally from them, and this lowering has been beautifully demonstrated in horses and may reach 25 mm. mercury (Chauveau and Kauffmann). But this lowering is compensated by many things, among others certainly by reflexes from the vaso-con-

* This influence which the lungs exercise upon the pressure in the thorax, on the structures inside it though outside the lungs, is the *pons asinorum* for many medical gymnasts. They cannot understand that the expansion of the thorax by muscular contraction in inspiration is the primary act, and that the expansion of the lungs when there is no pressure outside and atmospheric pressure inside is the result of the expansion of the thorax. It is therefore often difficult to change their fundamental idea that during inspiration the enlarged lungs *press* upon the other organs in the thorax. (N.B.—Negative pressure = a pressure that is less than atmospheric pressure.)

strictors. The heart's stronger action increases pressure, and *especially is it true that blood pressure, perhaps after a short fall, undergoes a decided rise during muscular work*, which in man may attain even to 100 mm. Hg. in the larger arteries. This is a marked increase, if one takes the whole normal pressure to be from 120 to 150 mm., and quite sufficient to form *a decided contra-indication to all strong movements in cases where there is danger of rupture of blood vessels.*

With Riva-Rocci's (Recklingshausen's) apparatus the normal blood pressure in the brachial artery is reckoned at 150 mm. (In severe arteriosclerosis it may reach even 300 mm.) Even in the capillaries we have normally 25 to 30 mm., in the veins of the head 7·5 to 12 mm. In the venæ cavæ in the thorax the normal is always at least several millimetres *negative* pressure. In the pulmonary circulation the same rule naturally applies as in the systemic circulation, and similar conditions, but the figures and alternations are less. In the pulmonary artery of a dog the pressure is about 20 mm.

The greatly increased blood pressure caused by strain serves as a warning to medical gymnasts. Strain is brought about by closing the glottis with the thorax in the position of inspiration, and innervating the muscles of the abdominal wall, especially rectus abdominis, the oblique muscles, and transversalis. It is a common occurrence, especially during defæcation, and is easily produced in many different muscular actions. It is not, however, normal, and must be avoided in medical gymnastics ; it is very dangerous in all conditions where there is danger of hæmorrhage. As we all know, it has a hampering effect upon the circulation, in that it changes the negative pressure outside the lungs in the thorax to positive, so that the return of blood to the right heart by the venæ cavæ is made difficult. Stasis arises in the systemic circulation, and in severe strain makes itself obvious by the altered colour of the face ; at the same time the pressure in the whole systemic circulation is considerably raised.

The rapidity of the blood stream in the vessels is increased by active exercise. The increased strength and frequency of the heart-beat assists in this, also the increased positive pressure in the aorta (and in the pulmonary artery), the extremely low pressure in the venæ cavæ (and in the pulmonary veins), and all the different momenta referred to above, which help in driving on the column of blood in the veins of the systemic circulation on their way to the right heart.

The rate of the blood stream, which, other things being equal, stands in inverse ratio to the breadth of the path, is well known to be greatest nearest the heart, smaller in the veins, and less still in those which are further from the heart, least of all in the capillaries, which form the widest

part of the circulatory stream. The speed varies enormously. Chauveau found it to be five to six times greater during movement than during rest. In the carotid artery of the horse it was 520 mm. a second during systole, 150 mm. during diastole. Tschuevsky found it up to 385 mm. a second in the carotid artery of a dog, Vierordt found it 0·8 mm. a second in the capillaries of the same animal—both of which results do not coincide badly with the usual theory that the stream in the capillaries is 400 times as wide as that of the aorta, and that, as already stated, the speed is in inverse ratio to the width of the stream.

Physical exercise has a definite and recognised influence on the composition of blood in diminishing the amount of water it contains, partly by increasing the amount of urine and perspiration given off, and partly by causing the protoplasm of the working muscles to become richer in water, so that the specific gravity of the blood is increased up to ·006; *the concentration of corpuscles is thereby temporarily increased.* Of the absolute increase of the red and white blood corpuscles and of their increased use and destruction, both of which probably take place as a result of physical exercise, we know very little. *That a sedentary life causes anæmia* is an opinion often expressed by doctors and certainly correct. We have also reason to suppose that when the arteries of the muscles dilate as the muscle contracts the branches of these arteries going to the marrow of the long bones also dilate, and that the formation of blood in the bone marrow thus becomes more active. It is also reasonable to suppose that the activity of the other blood-forming organs, especially of the spleen and lymphatic glands, is stimulated because the circulation as a whole becomes more active. *Contrasting with this favourable effect upon the formation of blood of muscular activity within physiological limits, is the severe anæmia known to follow extreme physical strain, especially the attacks of severe general spasm in tetanus* (*the infective disease*).

By its *strengthening effect upon the heart-beat* physical exercise helps to increase the blood-flow through the tissues, and thereby the rate at which oxygen is supplied and CO_2 removed. Tissue respiration is thus improved.

As we understand from the above, *physical exercise increases the work of the heart.*

We assume now that each of the ventricles at each systole presses out 60 to 70 cubic cm. of blood (into the aorta and pulmonary artery respectively). If the latter figure is taken, and the pressure in the aorta is taken as represented by a column of blood 1·5 m. high, the product of these results in work amounts to 0·08 kgm. for each systole of the left ventricle. If the analogous figure for the right heart is put at 0·03 kgm., we obtain, with O. Langendorff, a daily amount of work for the heart of

something over 11,000 kgm. in twenty-four hours. Other modern authors have arrived at 12,400 kgm.

In these estimates the inconsiderable amount of work of the auricular appendages and auricles has not been considered. During physical strain the work of the heart can be very considerably increased, but certainly not nearly to the extent supposed by the older authors.

I would point out in this connection a fact which is not sufficiently recognised in the medical world, that, owing to the influence of physical exercise on the heart's action, one can indirectly exercise a weak heart as one directly exercises weak skeletal muscles. This is the case to a remarkable extent in Stokes' (often inaccurately called Oertel's) "terrain-cure." In similar "cures," and in their influence upon respiration and ventilation of the lungs, we have an excellent therapeutic means of treating certain diseases and morbid conditions of the lungs (see later in the special part of the book).

* * * * *

The influence of active movements upon the circulation includes also effects on inflammatory processes and the products of inflammation.

Since active movements replete the part, they may also increase inflammatory processes. Neither is there any doubt that *excess of muscle action may*, on account of the strong hyperæmia to the working muscles, *produce acute muscle inflammation;* similarly, inflammation of tendon-sheaths is accounted for, both by patients and doctors, by muscular over-strain.

In acute inflammation local or general rest is the first indication.

On the other hand, we cannot doubt that *hyperæmia promotes reabsorption, and with products of inflammation other than pus, especially in chronic infiltrations due to myositis, movements act beneficially*, partly by hyperæmia of the muscles, partly also by the alternations of pressure arising in the muscular tissues.

As a means of promoting reabsorption, however, medical gymnastics is far inferior to massage.

* * * * *

Muscles by their activity exert a marked influence both on the intake of oxygen and on combustion (oxidation) within the organism.

Pulmonary ("*external*") *respiration*, or that process by means of which CO_2 from the blood is given off in the lungs and oxygen taken in from the atmospheric air, takes place largely through muscle action. The muscles of respiration, with which in this paragraph I am particularly concerned, form a special part of the motor apparatus, though other muscles which are equally part of this apparatus also sometimes assist in respiration.

I have already spoken of the influence of the muscles upon the circulation, which among other things is concerned with the distribution to the whole organism of the oxygen with which the blood has become loaded in the lungs.

I shall return below to the "*internal*" *parenchymatous respiration*, by means of which the oxygen in the tissues is used for oxidation and the production of energy.

Each respiration or breath consists of inspiration or breathing in and expiration or breathing out. By inspiration, as is well known, we enlarge the thorax in all three directions, and draw into the air passages the atmospheric air, which contains 20·93 per cent. oxygen, 0·03 to 0·05 per cent. CO_2, and 79·04 per cent. nitrogen, not reckoning that in this latter figure is included a certain amount of argon and other gases (0·9 per cent.). The expired air changes its composition very considerably, but contains on an average 16·7 per cent. oxygen, 3·6 per cent. CO_2, and 79·7 per cent. nitrogen. The CO_2 in the lungs has thus become increased about 100 times, and oxygen has lost quite a fifth of its volume. Moreover, the expired air is much richer in watery vapour than the inspired, and we give off by the lungs under usual conditions $\frac{1}{3}$ litre of water in twenty-four hours.

During physical exercise our need of oxygen is increased, owing to its increased use by the working muscles, which use more than the other tissues; and the muscle work for respiration itself is increased, because many muscles are working, and because the work of the respiratory muscles is thereby increased.

During rest we take very small breaths and inspire and expire 280 to 500 c.cm. of air. In lying or sitting position the latter figure is decidedly above the average. During rest we perform only twelve to fifteen respirations a minute,* and the whole ventilation of the lung may sink below 5 litres of air in a minute. As soon as we begin to move about we increase both the number of respirations and their depth; in forced work, especially in mountain climbing, we breathe something over twenty times, in hard "panting" even as many as thirty times, a minute, and we inspire and expire as much as 3,000 c.cm. with every respiration, so that the ventilation of the lungs is multiplied many times.

In calm and shallow respiration we only use for inspiration our external intercostal muscles and the diaphragm, possibly also to a certain extent the scaleni. In this men use the diaphragm more (abdominal breathing), women use the intercostal muscles more

* L. Hermann considers the average frequency for adults, not considering rest or movement, to be eighteen to twenty times a minute.

(costo-abdominal type). In forced inspiration we further contract sterno-cleido-mastoid, serratus posticus superior, the rhomboids, trapezius, levator anguli scapulæ, pectoralis minor, and serratus magnus.

In quiet and shallow respiration, expiration, as opposed to inspiration, takes place largely as a passive movement, with or without very slight help from the action of the internal intercostals.

The previously raised ribs sink of their own weight, the elastic attempt of the expanded lungs (and pleuræ) to contract also draws the ribs inward and downward and the diaphragm upward, and the elasticity of the thoracic wall and of the rotated costal cartilages also helps to make them return to the mid-position between deep inspiration and deep expiration. But as soon as we move there arises muscle action in expiration, and then besides the internal intercostal muscles, triangularis sterni, serratus posticus inferior, quadratus lumborum, sacro-costalis, latissimus dorsi, as well as the abdominal muscles, *i.e.*, rectus abdominis, the external and internal oblique muscles and transversalis are also brought more or less strongly into the work of respiration.

The vagus nerve is known to regulate the frequency of respiration and to contain both accelerating and retarding fibres. As already said, we have ceased to believe that there is an accelerating impulse as a reflex from the tissues thirsting for nourishment, but instead we consider that there is a direct stimulation of the respiratory centre by the products of muscular activity. These products consist not only of CO_2, since the increased ventilation of the lung during strong physical exercise diminishes the quantity of this gas in the blood (Zuntz and Geppert), but to a considerable extent also of lactic acid.

From the above it is clear that the work of respiration changes enormously, and that above all it accommodates itself to active exercise.

When Wislicenus (weighing 76 kilos) made his famous ascent of the Faulhorn, 1,596 metres high, the amount of work *in circulation and respiration* performed during the long seven and a half hours journey was 30,000 kgm., of which certainly considerably more than two-thirds was done in respiration.

Zuntz has given an average for the amount of respiratory work done in the twenty-four hours under ordinary conditions as about 25,000 kgm.

I would remind you that the air in the lungs can be divided into—

(1) *Residual air* = the air which we retain in the lungs after the strongest possible expiration. Opinions on the volume of this vary at least from 800 to 1,500 c.cm. This is divided into "*collapse air*," which leaves the thorax on its being opened, and the air which then remains, *i.e.*, "*minimal air.*"

(2) *Supplemental air* (reserve air) = that portion of the air in the lungs which after ordinary expiration remains in the lungs, but can be expired by means of the strongest possible expiration. This is on an average 1,000 c.cm. (Loewy and Zuntz).

(3) *Tidal air* = the air taken in and expired during ordinary quiet respiration (during rest). About 500 c.cm.

(4) *Complemental air* = the air which can be inspired after an ordinary inspiration by means of forced inspiration. Amounts to about 1,600 c.cm.

Supplemental air, tidal air, and complemental air together constitute the so-called "*vital capacity*," or, in other words, the greatest possible amount of air which we can expire (3,000 or 5,000 c.cm.).

With regard to the physiology of respiration, we entirely discard the unlikely "theory of secretion" (by means of the epithelium of the lung), and explain the interchange of gases between the blood and the air in the lungs, in accordance with many physiologists, by purely chemical and physical conditions.

The blood contains gases to the extent of 70 per cent. of its volume. At 0° C., and with the barometer at 760 mm., we have, according to Bohr :—

In arterial blood	20 per cent. oxygen. 43·6 per cent. CO_2. 1·2 per cent. nitrogen.
In venous blood	12 per cent. oxygen. 50 per cent. CO_2. 1·2 nitrogen.

The oxygen is to a large extent loosely combined with hæmoglobin in the red blood corpuscles (according to Bohr in the form of "hæmochrome"); only a comparatively small amount is found in the plasma, and this in simple solution. The CO_2 in the blood is combined mainly as carbonates, and to a less extent as phosphates and protein compounds. In addition, as much as will go into simple solution naturally does so. The small quantity of nitrogen is dissolved in the plasma.

In the venous blood in the lungs the pressure of oxygen is 22 mm. Hg. and the pressure of CO_2 is 41 mm.* In the atmospheric air the pressure of oxygen is about 152 mm., that of CO_2 0·3 mm. The pressure of gases in the alveoli of the lungs is not known, but from there in the whole length of the air passages to the opening at the nose or mouth the pressure of CO_2 diminishes; oxygen diminishes in the whole length in the opposite direction. As every gas goes from the place of higher to that of lower pressure, the oxygen, for this and other reasons, goes from the nostrils to the alveoli, CO_2 travelling in the opposite direction.

According to Speck, during rest we take in 0·461 to 0·601 grm. oxygen every hour for every kilo of body weight, and give off during the same time 0·535 to 0·717 grm. CO_2. This takes place by means of the surface area of the lung, which for a person weighing 70 kilos amounts to 80 to 90 square metres. The oxygen taken in combines loosely with the hæmoglobin (forming oxyhæmoglobin) in the red corpuscles. One grm. hæmoglobin contains 1·6 to 1·8 c.cm. oxygen, and the red corpuscles in the capillaries of the lungs represent a large area for absorption. Their

* In arterial blood the pressure of oxygen is given by Pflüger as 30 mm., by Bohr as 20 mm.; that of CO_2 is generally taken as about 20 mm.

surface area for the quantity of blood, reckoned at about 4 litres in the whole body, is said to amount to 2,560 sq. metres, or over ¼ hectar.

The "internal, parenchymatous" respiration, or the act by means of which in the capillaries we take CO_2 from, and give off oxygen (from the oxygen-laden red corpuscles) to the tissues, *is the real and final object of the whole process of respiration.* It is the "internal" respiration, which by means of the oxidising of carbohydrates, fat, and in all probability, under certain conditions, also of protein, produces the energy we require.

The production of CO_2 does not depend upon the ventilation of the lung, but really upon our muscular work.

During energetic muscle action, with simultaneous good ventilation of the lung, the blood takes up so much oxygen that it becomes richer in this than under normal conditions (L. Hermann); in other words, the blood in the veins becomes less venous, the blood in the arteries "hyperarterial."

Internal respiration constitutes a large part of the metabolism of the organism, but, as one now understands, *not the whole* of metabolism. For this consists not only of oxidation processes, but also of processes of disintegration, and probably also of synthetic processes.

Oxygen easily passes by way of the lymph from the capillaries, where its pressure is great, to the tissues, where it is least or (in the muscles) *nil.* CO_2 passes easily from the tissues, where its pressure is great, to the capillaries, where it is only 20 mm., and where CO_2 is taken up principally by the carbonates and to some extent by the hæmoglobin and other proteins and the phosphates.

As to the question of the seat of *internal respiration and of the whole of metabolism*, there are two chief currents of opinion.

The theory of Pflüger states that *internal respiration takes place chiefly in the tissues.* Probably, too, most physiologists hold the opinion that the cells of the organism are continually burning away their own component parts, and giving off products of combustion to the blood, from which also they continually take up and assimilate the food substances found there in order to replace those used up.

Voit and his followers consider the blood to be the seat of actual combustion and consider that the tissues take the second place. To a certain extent the theory of Voit coincides with that of Pflüger. For the blood is certainly a "moving tissue," and its cells, the blood corpuscles, undoubtedly perform in their own bodies some part of oxidation and of metabolism as a whole.

It is the CO_2 in the expired air and the nitrogen in the urine which enable us to estimate metabolism, CO_2 as regards the three organic food substances (protein, fat, carbohydrate), and the nitrogen of the urine as regards protein.

We may consider it certain that the combustion of the sugars in

the blood to CO_2 and water, which according to many authors is the only way, according to others one of the most important ways, of producing energy in the organism, goes on in all the tissues, quite vigorously in the working glands, but more actively in the working muscles than in any other tissue. Interchange of gases in the working muscle may be over twenty times as great as in the muscle at rest (Chauveau and Kauffmann).

The muscle itself does not contain free oxygen, but only CO_2 and some nitrogen.

During work the muscle changes its own chemical composition and that of the blood by using up glycogen, sugar, and fat; diminishes the organic combinations of phosphorus and increases mono-phosphates; increases the formation of sulphates by means of oxidation of the sulphur of the proteins to sulphuric acid; increases the oxidation of protein, at least under certain conditions, and with it urea, and changes its amphoteric reaction to an acid reaction—probably by the formation of lactic acid.

Many people think that the production of CO_2 in this way is not directly the result of oxidation, but of the disintegration of substances themselves formed by oxidation. Frogs give off nearly as much CO_2 in an atmosphere free from oxygen as in the air. But one thing is certain—that oxygen is necessary for the working muscle; without it the muscle becomes suffocated.

* * * * *

Physical exercise plays a most important part in regard to our need for food, in that it greatly increases this need apart from the question of body weight. Other causes of increase, such as cold, male sex, have a comparatively unimportant influence. The influence of brainwork is, if any, so inconsiderable that it can scarcely be calculated.

Our food consists of all the substances of which our bodies are formed, i.e., protein (and the so-called albuminoids gluten and gelatin), fat, carbohydrates (= sugar and starch), water, and those salts of which sodium, calcium, potassium, iron, carbon, phosphorus, and chlorine are essential parts. We take in all these substances by the mouth, and by "food" we at once and exclusively think of these. *But as "food" we may also reckon oxygen* which we inspire, and which is contained in most of the substances in the body and forms a necessary means of metabolism and of the production of energy.

If one wishes to reckon as foods all the substances which may be consumed by the organism and which give off heat, one must include *alcohol.* Every gram of this gives off seven calories when completely oxidised to CO_2 and H_2O. But alcohol is not only an abnormal constituent of the body, but also a poison which can only be taken in very small quantities without obvious harmful effects; let us say only $\frac{1}{4}$ grm. in twenty-four

hours per kilo of body weight. Its effect upon mechanical and other power of work is doubtful; for my part I incline to the opinion that in the long run it lowers power of work.

Protein has been called the plastic food-substance, as it forms the most important solid substance in the protoplasm of the cells; while carbohydrates and fats are considered as "respiratory" or heat (and movement) producing foods. However, it may now be considered as certain (see below) that protein also under certain conditions may be concerned in the production of vital force. This is also the case with gluten, which can certainly not take the place of protein, but is of considerable value in saving protein. An animal receiving only gluten, fat, carbohydrate, water, and salt lives considerably longer on this food than it does if gluten is omitted.

Salts and water have no value for combustion, and are thereby distinguished from the real food substances. But both are absolutely necessary constituents of the tissues and indispensable for the physical and chemical processes of life. As regards salts especially, their exclusion from our diet causes death more quickly (through poisoning by organic sulphates) than the simultaneous exclusion of protein, fat, and carbohydrate.

In our food substances, carbon, hydrogen, oxygen and nitrogen atoms, as regards protein and carbon, hydrogen and oxygen atoms, as regards fat and carbohydrates, are combined with one another in such a way as to form molecules of the respective substances, so that these represent chemically stored force. The work necessary for this is originated by the light of the sun, and performed by means of the chlorophyll (green colouring matter) of plants or modifications of this. The force lies in the fact that the atoms in the protein, fat and carbohydrate, with their comparatively loose chemical combination, are similarly built up with each other to form (very complicated) molecules. By oxidation in the organism these very complicated molecules (formed only by loose chemical combination) break up into very much simpler, more firmly combined molecules. When, therefore, the strong attraction between the atoms (attempt towards union) which constitutes chemical energy is done away with by their union, the latter is changed to heat. Many people now think that the *whole* quantity of energy first becomes heat, and that a portion of it afterwards is in some unknown manner changed to movement.

We measure mass movement in kilogrammetres and heat in calories. A kilogrammetre is the amount of work necessary to lift one kilo one metre. A (large) calorie is the amount of heat necessary to raise the temperature of a litre of water (volume reckoned at 20° C.) 1° C. A calorie corresponds, according to L. Hermann, to 426 kilogrammetres of work or force; 1 kilogrammetre is therefore = 0·0002347 calories. Others count a calorie = 425 kilogrammetres.

In connection with terms of work and allied terms I would refresh the reader's knowledge of physics by reminding him that a kilogrammetre is a definite *term of work*—that it requires a definite amount of work to raise a kilo 1 metre, and that the work thus stored up as elastic force expresses itself as a definite amount of vital force when the said weight

again falls 1 metre. As the unit for vital force—kilogrammetre—is the same as for work, so work = vital force. By combining the term of work with a condition of time we obtain quite another idea, which we call *power of work* or *effect*. What is usually called horse-power is that effect or power of work which enables a machine to perform 75 kilogrammetres of work in a second. As a measure of vital force we take the work which a body can perform by its velocity. If the mass of the body $= m$, its velocity $= v$, the vital force $= \frac{mv^2}{2}$. For other fundamental equations in dynamics see the text-books on physics.

Since the Congress in Paris in 1881, electricians have adopted an absolute system with a unit of length = 1 cm. or 0·01 of the length of the standard metre in Paris, a unit of mass = 1 grm. or 0·001 of the standard kilogram in Paris, a unit of time = 1 second or $\frac{1}{60}$ of $\frac{1}{60}$ of $\frac{1}{24}$ of an average twenty-four hours. Further, as unit of velocity they have taken a distance of 1 cm. per second; as unit of acceleration an increase of this velocity by the same unit of velocity; as unit of force 1 dyn = the force which gives to the mass of 1 grm. an acceleration = the said unit of acceleration; as unit of work 1 erg = the work performed by 1 dyn when the distance in the direction of the force is 1 cm. (1 joule = 10,000,000 ergs). The unit of power of work or effect = a power of work of 1 erg in 1 second (a watt = an effect of 1 joule in 1 second).

Theoretically we must distinguish between mass and weight. The mass is the measure of the resistance offered by a body to the force which is required to alter its state by movement; the mass of a body is therefore the same wherever the body is placed in the universe. The weight, again, is the pressure which a body exerts on the underlying surface on account of the attraction of the earth, and varies with the distance of the body from the centre of the earth, which is somewhat different at different latitudes and at different heights above sea-level.

In the ordinary cultured, moderately active life we need rather over 30 *calories in twenty-four hours per kilo of body weight, which we take in as protein fat, and carbohydrate in the proportions of a "good mixed diet." As representative of such a diet one may take in somewhat round figures the well-known scheme of Voit, i.e.,* 120 *grm. protein,* 60 *to* 90 *grm. fat, and* 300 *to* 500 *grm. carbohydrate.* This daily amount will suffice only at its maximum for a tolerably well-grown person doing hard work. Neither can it be taken as an absolute example of proportion. Teutonic races especially, often from choice, take more fat and protein than Voit's scheme allows.

Rubner gives the desirable proportions of the three important organic food substances as $\frac{1}{6}$ protein, $\frac{1}{6}$ fat, and $\frac{2}{3}$ carbohydrate.

Forster's investigations give on an average 131·2 grm. protein, 88·4 grm. fat, 329·3 grm. carbohydrate, and 2945·9 grm. water. The amount of water necessary varies enormously with physical exercise and perspiration, and according to the food taken and the amount of salt it contains, but for a well-grown person under

ordinary conditions amounts to 3½ litres in twenty-four hours, and is taken in, as we all know, partly in the form of various drinks, partly in the solid food substances, which usually contain a large quantity of water.

A person, probably a very small person judging from the quantity of urine, lost, according to Pettenhofer and Voit—

during rest	in the urine	1,212	grams water.
	in the excretions	110	,, ,,
	in perspiration	931	,, ,,
during moderate work	in the urine	1,155	,, ,,
	in the excretions	77	,, ,,
	in perspiration	1,727	,, ,,

We receive from the food in *gross value* per gram of

Protein.	Fat.	Carbohydrate.
4·1 calories	9·3 calories	4·1 calories

and after subtracting the amount which leaves the body undigested in the excretions, on an average a *net value* of

Protein.	Fat.	Carbohydrate.
3·2 calories	8·4 calories	3·8 calories

While we increase our physical exercise we increase continually the amount of heat produced, and in order to maintain our equilibrium we must take in a much greater supply of calories of nourishment than that which would only correspond to the extra work. *The need of food thus increases rapidly with physical exercise, and when the latter varies much the former is also very variable.* A person lying in bed certainly requires barely 30 calories in twenty-four hours for every kilo of body weight. A fairly active person, not a manual labourer, disposes easily of 35 to 36 calories per kilo in twenty-four hours. The Swedish workman, who on an average weighs about 70 kilos and is generally very disinclined to overwork, generally uses up about 3,000 calories, *i.e.*, nearly 43 calories per kilo body weight, in twenty-four hours. American students (in California), who, with an average weight of 70 kilos, played football a large part of the day, consumed daily per person 217 grm. protein, 416 grm. fat, and 710 grm. carbohydrate, which makes nearly 100 calories net per kilo in twenty-four hours. One calorie corresponds to 425 kilogrammetres, and about one-third of the calories must have been used up by the young men in physical work! In general, 300,000 kgm. is considered a "fair," 400,000 kgm. a "stiff," day's work.

While physical exercise increases the need of food, it also increases the tendency to take in more food and the power of complete digestion. The effect of physical exercise *in increasing the*

appetite belongs to those phenomena which may be noticed by any one; the same may be said of its effect upon *defæcation*.

Many people have tried to show the *beneficial effects of physical exercise upon secretion in the glands of the alimentary canal, the pancreas, and liver*. On the whole such an influence is highly probable. But *while digestion is actually going on* severe physical exercise is always to be avoided, because all the digestive glands are then secreting more than at other times, and are consequently the seat of a widespread hyperæmia, as is the case in all organs during increased activity. This causes blood to be taken from the muscles, and consequently counteracts (the desire for) movement.

Speaking of the effects of active movements upon the activity of glands, I must here put in a word as to their effects upon the kidneys, skin, and genital organs.

The functions of the kidneys are increased by physical exercise, in that the quantity of urine is first increased; at the same time the specific gravity of the urine usually sinks. After prolonged marches with profuse perspiration we often find a scanty, concentrated urine with high specific gravity. Zuntz and Schumburg found that a clinically unimportant albuminuria, not uncommon in young persons, vanished during a march. But many researches prove that excessive marches, on the other hand, may often *cause* albuminuria, and that they easily produce relapse of recently cured nephritis, probably through irritation of the kidneys by the over-concentrated blood and urine after profuse perspiration.

On the genitalia physical exercise has a regulating effect. Fatigue is accompanied by lowered functional power, and the practitioner finds in energetic physical exercise a good means of lessening excessive sexual feeling in young men, and of promoting moderation in the exercise of the sexual functions, or even total abstinence, which is often difficult, though socially beneficial and hygienically harmless. On the other hand, the doctor often sees that systematic physical exercise in persons with sedentary habits and with weak potency produces a considerable increase of the latter.

Physical exercise strongly influences the quantity of blood in the skin and its secretory functions, which are increased. Perspiration, as already said, may reach a very high amount. After physical exercise, and especially when resting after it, there is considerably more danger of taking cold than at other times, and the usual well-known measures should be taken for avoiding this.

In a "*good mixed diet*" protein, fat, and carbohydrate may, to a certain extent, take the place of one another according to the above value in calories. But it must be said that all diet for human beings, in order to be good, must be mixed and within certain limits must contain *all* the

three organic food substances. The exclusion of fat is borne best, that of protein worst.

If protein is omitted the excretion of nitrogen by the urine continues, though diminished, till death, of which there is much more danger than when both fat and carbohydrate are excluded. Carnivorous animals are able to live *ad infinitum* on protein, salts, and water; in man and other omnivorous animals a similar diet produces loss of appetite, severe disturbances of digestion, etc.

The older men of science now living consider in general that protein is able to build up protein, fat, and carbohydrate in the human organism; that carbohydrate can build up fat and carbohydrate; and that fat is unable to make anything but fat. It seems to me not improbable that in the future these opinions may become better grounded and more generally accepted than they are now.

However, in these days the various proofs hitherto offered of the formation of fat from protein (by means of the separation from it of a molecule containing nitrogen) are not considered complete.* I consider the fact that protein can form glycogen, *i.e.*, carbohydrate, has been proved beyond all possibility of doubt—by the important and minute investigations of E. Külz particularly.

It is certain that carbohydrate is able to form carbohydrate and fat in the organism; we need not concern ourselves with the doubts as to the formation of fat which crop up here and there.

Skilful investigators find, what speaks for itself, that all which eventually is consumed for the production of energy within the organism must be carbohydrate (glucose). As no one doubts that fat maintains energy, the said investigators assume that fat within the organism can form carbohydrate. I consider that important well-known facts are opposed to this view. If an animal is starved until its liver glycogen has sunk to a small but definite amount, and if the animal is then fed on fat alone, the liver glycogen continues to sink (see Seegen's figures, but not his opinions). In diabetics, with minimal power of assimilation of carbohydrates and maximal production of sugar in the urine, the sugar in the urine is not increased by eating butter. It is difficult to understand how either of these facts could be if fat under any conditions could form carbohydrate within the organism. If all vital force in the organism were produced by glucose, a certain caloric value of this material (as Zuntz remarks) should support more muscle work or give more warmth than the same caloric value of protein or fat, to change which into carbohydrate would mean a considerable loss of power. This is not the case in Zuntz's careful and exhaustive experiments. For the present, therefore, we have far more arguments against than for the opinion that fat can form carbohydrate, or that all that is finally oxidised within the organism is carbohydrate. We have long hesitated to accept the theory

* All scientists ought to be, and the majority are, very sceptical, especially the elder ones who have seen so many rooted ideas unmercifully uprooted. But to make older doctors believe, *e.g.*, that fat in a fatty liver after phosphorus poisoning does not come from fatty degeneration of cell protoplasm but from fatty infiltration is difficult enough. A priest said to me recently, quite seriously and solemnly, "We cannot but believe in the devil." I found the man a little obstinate, but with regard to the question of fatty degeneration I recall his remark, and for my own part say, "I cannot but believe in fatty degeneration."

that muscle is able to break up the fat molecules, which to our minds appear so firm, and it is still a mystery where this breaking-up first takes place. But since we now know that fat, in being broken up to carbonic acid and water, certainly without a moment's delay passes through the molecular formation of β oxybutyric acid, diacetic acid, and acetone, and as we believe that muscle or any other tissue has the power to oxidise β oxybutyric acid to diacetic acid, this to acetone, and the acetone to carbonic acid and water, we are more inclined than formerly to believe in the power of muscle to break up fat molecules.

The younger Cohnheim considers that he has shown that albumose and peptone in the mucous membrane of the alimentary canal are broken down to form amino-acids by means of a ferment (erepsin), from which afterwards proteins peculiar to the body may be built up in the tissues. In addition, carbohydrates and, to a less extent, fats may also assist in the synthesis of proteins in the body by supplying the necessary carbon, hydrogen, and oxygen.

The question whether protein is able to maintain muscle work has been handled for a long time and by means of extensive experiments. There is no doubt that both fat and carbohydrates are able to do this. Neither is there any doubt that protein in the organism is able to form carbohydrate, so that it cannot be questioned that the former substance can at least *indirectly* maintain muscle work. But it is now generally accepted that as long as muscle work is not excessive and the supply of carbohydrate and oxygen sufficient, there is practically no change in the nitrogenous output. The final decision seems to be that the expenditure for muscle work is primarily borne by the glycogen of the liver, which is quickly changed to sugar in the blood and afterwards is fetched from the various storage places. Muscle glycogen is more stable and the sugar in the blood is inconsiderably diminished by muscle-work alone, and only late during starvation.

The greater the proportion of one of the three substances of which the food taken consists, the more is the use made of this substance increased, which is shown partly by respiration and partly (with regard to protein) by the quantity of nitrogen in the urine.

All muscle work, static and motor, eccentric and concentric, increases the consumption of oxygen and the production of CO_2 (Johansson), *and both these substances are increased, irrespective of the work, by the supply of all three kinds of food substances, protein, carbohydrates, and fat* (Speck, Tisot).

Johansson in Stockholm has shown that *during rest* the production of carbonic acid is increased both by taking in protein and carbohydrate (lævulose), which may both be supposed to form fat by the liberation of carbonic acid, but that the production of carbonic acid, on the other hand, is unaltered by the ingestion of fat, which *during rest* is entirely stored.

It is well known that the change to muscular energy and heat of the chemically stored energy in protein, fat, and carbohydrate takes place by the oxidation of these substances, and their breaking

up into simpler molecules in the tissues wherever blood and cells are present, therefore, even in resting muscles (Meade-Smith), but that *these changes take place much more quickly and strongly in working muscle than elsewhere. Chauveau and Kauffmann showed experimentally that a muscle doing moderate work consumes many times as much sugar as glandular tissues or resting muscle.* Under normal conditions the consumption of oxygen and the production of carbonic acid in the lungs correspond to the complete oxidation of the assimilated food substances, although the *respiratory quotient, or the proportion of oxygen to carbonic acid* $\left(\frac{CO_2}{O}\right)$, varies somewhat, for purely chemical reasons, with different foods, and is greatest with pure carbohydrates. It amounts to about 1, and may even rise above this. With pure unmixed proteid food it is about 0·8. With unmixed fatty food, 0·71. In starvation it is at first at a fairly high figure while the glycogen of the liver is being consumed; afterwards it sinks quickly and approaches the same figure as that of fat (Koræn). Speck's experimental rest cases gave off 0·461 to 0·601 grm. oxygen (= 0·322 to 0·420 litre) and 0·535 to 0·717 grm. carbonic acid (= 0·271 to 0·364 litre) per kilo of body weight every hour. The respiratory quotient was in this case on the whole greater than 1 when the oxygen took part in other oxidation processes than that of forming carbonic acid, forming in particular water. The muscles are able to form carbonic acid by destructive processes without taking up oxygen, but oxygen must take part in the formation of the substances capable of being broken up. *During work therefore the quotient rises; during rest it sinks.*

By as complete rest as possible a person weighing 80 kilos can limit his production of carbonic acid to 20 grm. per hour. In changing from rest to a stiff standing position the gaseous changes show an increase of about 20 per cent. In walking the consumption of oxygen and production of carbonic acid rises two to four times its amount during rest (Zuntz); hill-climbing and other hard mechanical work raise it extremely (to over 130 grm. per hour), and heat production rises at the same time, as I have already pointed out (Atwater and Benedict). A person who during rest expended 2,357 calories, of which 429 were supplied by protein and 1,928 by fat and carbohydrate, expended during work 5,119 calories, of which 462 were supplied by protein and 4,657 by fat and carbohydrate. In hill-climbing Zuntz found that 1 kilogrammetre of work used 0·0072 calorie. Since a kilogrammetre corresponds to 0·0026 calorie, this agrees with the view that about one-third of the force used is transformed into work, two-thirds into heat. According to Johansson and Koræn every kilogrammetre of external work caused a production of 0·004 grm. carbonic acid. Here we must call to mind that the CO_2

in expired air corresponds to different heat values, according to whether protein, fat, or carbohydrate has been oxidised in the body.*

In static muscle work, according to Johansson and Koræn, *the production of carbonic acid is proportional to the muscles' time of contraction, and rises more than in proportion to their shortening*, so that when the muscles are shortened to the maximum the production of carbonic acid is about five times greater per second than when they are contracted *bei natürlicher Länge*. Both in static muscle work and in eccentric resistance movements (= " negative muscle work ") the production of carbonic acid increases in proportion with the *time of contraction* within certain limits; and the increase during eccentric muscle work is not greater than can be ascribed to static muscle work. On the other hand, *as soon as fatigue arises the production of carbonic acid increases more quickly.* (The explanation of this is given later.)

Johansson's and Koræn's experiments show that in concentric resistance movements the production of carbonic acid increases proportionately with the number of movements after some practice, but that its production increases more quickly than in this proportion before the individual has had some practice. The carbonic acid increases in proportion to the time of contraction and to the resistance (= the load); with a heavy load and slow contractions, however, more quickly than according to this rule. It is, especially during slow contractions, greater during the later than during the earlier stages.

Since muscle work, consumption of oxygen, and production of carbonic acid increase with the time of contraction, and since the same movements may require very different work, according as the contracting muscles alone or their antagonists also are innervated (which according to Kohnstamm is especially the case in fatigue), it may easily be that slow movements, even slow walking, expend more than quick movements and quick walking, although quick walking, for the following reasons, costs more in consumption of food substances than slow walking (see further on Self-resisted Movements).

The relation between that part of the whole energy produced which becomes heat and that part of it which becomes work varies enor-

* —	Calories for each gram of carbon breathed out.	Relative count.	Calories for each gram of oxygen used.	Relative count.
Carbohydrate	9·5	100	3·53	107·3
Pure meat .	10·2	107	3·30	100·3
Fat . .	12·3	129	3·29	100·0

mously according to the kind of work. By comparisons, in regard to this, between static, eccentric, and concentric work, we notice at once that in static muscle work no movement takes place apart from the flow of blood and lymph in the vessels and the "protoplasmic" movements in the cells; *all the energy which in ordinary free movements appears in them, in static work becomes heat.* The tetanised muscle of a frog becomes heated as much as 0·18° C. (Helmholtz).

With eccentric work we get extremely varying conditions. If, says L. Hermann, I call A the work necessary to hold a weight for a certain time in the hand at the same height, the weight p, the height h, the time t, and the force of gravity ph, the eccentric work, if I allow the weight to sink, $= At - ph$, the concentric work to raise it again to the same height $= At + ph$, and the work done to both lower and raise it $= At$. Similarly, it is clear that in letting the weight *sink*, not *fall*, I am able to use *all* the different quantities of work, even from that which is only the least amount less than the work required to hold the weight at the same height, to that which is the least amount more than no work in letting it fall, without in the least diminishing the speed of its fall. Since in eccentric movement the patient himself does no part of the external movement, and performs less work than he must perform for concentric movement, *he develops less heat in eccentric than in concentric movements, other things being equal.*

How much of the whole of the energy developed in our ordinary free movements and concentric resistance movements gives rise to heat and how much to movement is not definitely known; it certainly varies considerably.

O. Weiss considers that movement represents from one-fourth to about one-third of the whole amount of energy. Zuntz considers that in warm-blooded animals one-third of the whole amount of energy is the maximum represented by movement. In frogs, and probably in other cold-blooded animals, this may, according to Danilewsky, stand in the proportion of 1 : 1.

We must, however, remember that a large part of the force which is at first changed to movement is later changed to heat. For example, when the blood arrives at the right auricle there is no longer any of the systolic force of the heart remaining. It has become heat owing to the friction between the blood and the walls of the vessels, and largely owing to the friction in the narrow capillaries; a quantity of heat is produced which altogether, according to L. Hermann, may reach one-ninetieth of the whole amount necessary to the organism. When in walking we use muscle force to lift the trunk, and then put the swinging leg

obliquely downwards and forwards on the ground—the foot remaining in its place owing to friction against the ground—and the body falls forward again of its own weight, movement is also changed to heat, to a large extent in merely preventing the fall of the body downwards, and not considering the heat produced by friction between the foot and the ground.

Our greatest task under normal conditions is *to replace the loss of heat by radiation and conduction*, which two factors we cannot practically distinguish from each other. They take place to a great extent through the skin, and to a less extent through the lungs.

On the whole each separate part of the organism, under normal conditions of the internal organs, is kept at a very slightly varying temperature, which, apart from the usually lower figure in the more peripheral and the slightly higher figure in the more central parts, we are accustomed to state at an average of 37·5° C.* In the extremely complicated heat-regulating apparatus of the organism, the highest forces of which belong to the cerebro-spinal nervous system, there remains yet much for us to learn, and I do not propose here to enter into this subject. I will only remind the reader that considerable variations in the expenditure of calories take place according to the temperature of the surrounding air. Johansson has recently demonstrated that the variations which take place normally in the warmth of the body are determined to a large extent by digestion, but first and foremost by muscle work. By vigorous muscle work the temperature of the internal organs may, according to Johansson, rise about 0·5° C. Zuntz noticed (what is to me astonishing) that a quarter of an hour's mountain-climbing in the sunshine produces a temperature in the rectum of 39·5° C. without other unphysiological phenomena. Even if this figure is too high, it seems certain that the increased expenditure of heat—by quick conduction from the warmed hyperæmic skin, by increased evaporation from the skin, and from the lungs, by increased catabolism, etc.—does not succeed in fully counteracting the increased production.

In order to obtain *nutritive equilibrium* it is necessary that the output and income of the organism shall be equal. We have already seen the value of protein, fat, and carbohydrate. In order to give an idea of various expenditures in calories I insert here a

* In the adult one finds a temperature of 36·7° to 37·2° C. in the rectum; in the axilla 0·2° to 0·6° C. less. The skin is usually 32°, in some places 34° to 35° C., but varies considerably. In the internal organs in larger mammals, including man, the temperature is normally as much as 40° C.; it is highest in working muscles and in glands—highest of all in the liver. When taking temperature in the axilla this must be made into an "internal cavity" for fifteen minutes by being closely surrounded by adduction of the arm.

table of Atwater's showing the expenditure during twenty-four hours for a man weighing 64 kilos.

The loss of heat by the lungs is very variously reckoned; Helmholtz gives it at 70, Rubner at only 35 calories.

Evaporation both by the skin and lungs is reckoned by Rubner at 558 calories during rest; by Helmholtz from the lungs alone it is reckoned at 397·5 calories.

Evaporation from the skin varies according to the *secretion of perspiration*, and this varies enormously. On an average it certainly does not exceed 700 c.cm. But it *can* amount to 4 litres in twenty-four hours, and every litre in evaporating at a temperature of 37° C. uses 580 calories. A large part of the expenditure in evaporation is borne certainly by the air, but a considerable part is borne by the organism.

—	Rest (Calories).	Moderate work (Calories).
Radiation and conduction . . .	1,683	3,340
Contents of intestines . . .	31	26
Evaporation from skin and lungs . .	548	859
Work	—	451
Total calories . . .	2,262	4,676

A complete summary of the expenditure and receipts of the organism is worked out on p. 118. I must here omit the experimental technique.

To obtain a correct idea of *the development and use of forces in the movements of the body, especially in the most important of all movements from the hygienic and therapeutic point of view, namely, walking*, we must remember the most important of the forces which help or hinder our muscular force.

We know that every moment different forces make themselves felt, and that a movement which has once been imparted to a mass according to the laws of physics is continued to all eternity, so long as no other forces counteract and diminish it, or work with and increase it. On the earth we are continuously under the influence of *gravity*, which to a great degree influences the visible expression of our muscle work and the expenditure on movement. We have moreover the *resistance of the medium in which we live.*

In comparison with the resistance to our movements offered by the mass of the body, gravity, and the resistance of the air, we may

fortunately consider the friction in our joints, tendon sheaths, between muscles, etc., and other slight resistances as "negligible quantities."

We all know that it takes more coal to drive a steamer by water (and air) at 20 knots an hour than to drive it the same distance at 10 knots, even though a speed of 20 knots has once been reached,

A man (69·3 kilos in weight; after the experiment 69·5 kilos) (Pettenkofer and Voit).

—	Grams during 24 hours.	Water.	C.	H.	N.	O.	Ash.
Intake.							
Meat	139·7	79·5	31·3	4·3	8·50	12·9	3·2
Albumin	41·5	32·2	5·0	0·7	1·35	2·0	0·3
Bread	450·0	208·6	109·6	15·6	5·77	100·5	9·9
Milk	500·0	435·4	35·2	5·6	3·15	17·0	3·6
Ale	1025·0	961·2	25·6	4·3	0·67	30·6	2·7
Cooked fat (Schmalz)	70·0	—	53·5	8·3	—	8·1	—
Butter	30·0	2·1	22·0	3·1	0·03	2·8	—
Starch	70·0	11·0	26·1	3·9	—	29·0	—
Sugar	17·0	—	7·2	1·1	—	8·7	—
Salt	4·2	—	—	—	—	—	4·2
Water	286·3	286·3	—	—	—	—	—
Inspired oxygen	709·0	—	—	—	—	709·0	—
		2016·3	—	224·0	—	1792·3	—
Total.	3342·7	—	315·5	270·9	19·47	2712·9	23·9
Expenditure.							
Urine	1341·1	1278·6	12·6	2·75	17·35	13·71	18·1
Solid excrement	114·5	82·9	14·5	2·17	2·12	7·19	5·9
Expired air	1739·7	228·0	248·6	—	—	663·1	—
		2189·5	—	243·30	—	1946·2	—
Total	3195·3	—	275·7	248·22	19·47	2630·2	24·0
Intake—Expenditure	+147·4	—	+39·8	+22·7	±0·0	+82·7	—0·1

The above table gives the reader an idea of the most important points, in such an investigation, as to our need of water and of the elements C, H, N, and O in their mutual relation, and of salts. But it applies to a man in a condition of comparative rest.

since the resistance of water and air increases with the velocity, neglecting the slight necessary friction between the different parts of the machinery. In walking similar influences are felt, and, in spite of the above-mentioned fact that slow walking *may* use more muscle work than quick walking, as a rule quick walking uses more muscle force and chemical force (in fat and carbohydrate), due to the resistance of the air, friction in the joints, etc.

Since the expenditure for this resistance is *comparatively* greater

for a small than for a tall person, the latter, especially in quick walking, moves with less expenditure than the former.

Movement through a certain distance on the horizontal costs less than movement for the same distance uphill, more than movement for the same distance downhill; in the former case the movement is hindered, in the latter case helped, by gravity. It costs more to pull oneself up between ropes and overcome the force of gravity by concentric muscle work than to come down the same distance and merely exercise the necessary resistance against gravity to moderate the rate of fall. To walk, and so impart movement to the body mass, costs more than to stand. It costs more to run than to walk, partly because of the more rapid movement and the thereby increased resistance, partly because at each step in running one entirely leaves the ground. It is still harder to jump, since one throws the body in a direction more or less at right angles to the force of gravity.

Marey has shown that those who walk with bent knees and body leaning forward walk farther for a certain number of calories than those who walk with more upright bearing. To keep the knees bent means a greater expenditure than to keep them straight, because the muscle work holding the knees bent at an angle is greater than with straight knees, since the body weight has more leverage. But the lifting of the trunk which is constantly taking place in walking is greater with straight than with bent knees, and it is this that determines the result.

Lastly, we have good reason to believe that a fresh worker who has rested well can perform more *external* work for the same expenditure than a tired worker or one who is ill, a subject to which we shall return in considering over-strain, and which I consider is not yet fully explained, but which probably is due to the fact that fatigue, illness, or other unfavourable influences make it impossible completely to control innervation of the antagonists of the working muscles.

To calculate the work in hill-climbing one multiplies the height of the mountain by the weight of the climber and adds to the product a value obtained by multiplying the distance travelled by a coefficient which changes and rises with the velocity, also multiplying this product by the body weight. In other words, one adds to the mechanical work of the lifting the mechanical work for the distance taken as if horizontal. Leo Zuntz calculated that for a person weighing 75 kilos to climb a height of 2,200 metres in a distance of 22 km. the expenditure is $75 \times 2{,}200 =$ 165,000 kilogrammetres for the height + 132,000 kgm. for distance = 297,000 kgm.

He further calculated that in walking on the horizontal at a speed of 3·6 km. per hour the work = the body weight multiplied by one-twelfth

of the distance ; with a speed of 6 km. the multiplier rose to about one-tenth of the distance ; when the speed increased to 8·4 km. the multiplier increased to one-sixth of the distance. The consumption of oxygen rose with the different speeds three to four to ten times ; the inspired and expired air two to three to six times.

The expenditure per km. an hour for a person weighing 70 kilos was—

For a journey of 3·6 km. 40·3 calories.
„ „ 6·0 „ 47·2 „
„ „ 8·0 „ 78·6 „

In racing a distance of over 100 metres in twelve seconds the work done amounted to 7,230 kgm. a minute.

By the help of mechanical devices one may travel a distance with much less expenditure than by using only one's own motor apparatus. A comparison of the expenditure of the above individual in walking and in cycling was as follows :—

	Walking.		
Distance per hour :	3·6 km. ;	6 km. ;	8·6 km.
Expenditure per hour :	40 calories ;	47 calories ;	79 calories.
	Cycling.		
Distance per hour :	9 km. ;	15 km. ;	21 km.
Expenditure per hour :	20 calories ;	21 calories ;	26 calories.

If the road ascends, the expenditure of force in cycling increases greatly. If the weight of the cycle and the rider together is 90 kg., in travelling 15 km. an hour on the horizontal little more than 2,960 kgm. of work is done. In a 3 per cent. rise, *e.g.*, 30 metres rise per kilometre, the expenditure is increased by $30 \times 90 = 2{,}700$ kgm., and the work is therefore nearly doubled.

From what has been said on food, force production, and force consumption within the organism the importance of physical exercise in anomalies of nutrition is obvious. *Over-nutrition*, when we take in more than we use and increase in weight, *nutritive equilibrium*, where our intake and expenditure cover each other, and *under-nutrition*, when our expenditure rises above our intake and we become thin, *are all relative terms, which, irrespective of food supply, are chiefly determined by our movements. Just as rest plays a great part in the treatment of thin patients who are below their normal weight, so exercise plays an important part in the treatment of obesity. A great prophylactic influence has for long been ascribed to exercise in regard to gout and diabetes, and it is believed to have a great therapeutic value in the treatment of these still somewhat mysterious dystrophies.*

* * * * *

In discussing the influence of gymnastics on the nervous system, as in all else, I assume the reader's knowledge of the anatomical conditions

connected with it. But with regard to the study of neurons worked out by Waldeyer, Forel, His, and others, whose opinions vary markedly in detail, but agree fairly well in the main, I consider it my duty to put forward here the various opinions of modern anatomists. It is also suitable to mention briefly the connection between the various parts of the nervous system.

I will remind you first of the arrangement of the motor and sensory neurons in the cerebro-spinal nervous system.

If we follow one of the numerous motor neurons from its ganglion cell anywhere in the cortex of the cerebrum to its muscle end-plate, which finally gives up to the muscle the impulse which it was carrying from the said ganglion cell, we meet on the way at least two of the anatomical units, consisting of ganglion cell, nerve fibre and end apparatus, which form the modern histologist's neuron. The central of these two neurons begins with an automatic motor voluntary ganglion cell in the cerebral cortex, goes thence through the pyramids, in such a manner that the non-decussated fibres go by the anterior longitudinal fissure *via* the anterior pyramidal tract, while the decussated fibres travel in the lateral (pyramidal tracts) columns of the cord to a ganglion cell in the grey matter of the cord. The central neuron ends in the immediate vicinity of the dendrites of this ganglion cell, from which the impulse travels across in some unknown manner to the peripheral neuron, though it must be noted that *structurally* the neurons are, as everywhere, distinct from one another.

The latter (peripheral) neuron begins in the above-mentioned ganglion cell, passes as a nerve fibre in the anterior column of the spinal cord, and through one of the anterior nerve roots out of the cord (accompanied by other centrifugal (motor, secretory, and vaso-motor) nerve fibres) to some skeletal muscle, and ends there in a muscle "end-plate."

The sensory, centripetal paths are more complicated, and much still remains to be discovered before we can really claim to understand them. In discussing them I follow to a large extent the diagrammatic plates given us by Mott (p. 288 in L. Hermann's latest edition). We begin then to follow the nerve path from the periphery, and from one of its end apparatus in the skin, in a tendon, muscle, or joint capsule (from a tactile corpuscle or a Pacinian body). The sensory fibre passes in a spinal nerve towards a spinal ganglion, from one of the ganglion cells of which it originates in the following manner. Each ganglion cell gives off only one process, an axon which very soon divides in a T-shaped manner to give two branches, one of which is the sensory fibre coming from the periphery, while the other passes into the spinal cord by way of the posterior or dorsal nerve root, and then runs upwards in the posterior columns of the spinal cord, either in its medial (Goll's) fasciculus (= funiculus gracilis) or in the lateral (Burdach's) fasciculus (= funiculus cuneatus). On its course it gives off collateral branches, some of which communicate indirectly with the motor ganglion cells in the anterior horn of the cord by means of an intermediate neuron. One of the collateral branches of the ascending division ascends in the posterior part of the cord to a ganglion cell in Clarke's column, from which axons arise which ascend still further in the direct cerebellar tract in the lateral

column to the cerebellum and arborises round a Purkinje's ganglion cell. It is to be remarked that this cell sends out a centrifugal neuron, which by means of an intermediary neuron is connected with a motor ganglion cell in the anterior horn of the cord.

But the fibre spoken of above as coming out from the spinal ganglion cells gives off a still longer branch, which ascends in Goll's or Burdach's fasciculus of the posterior column of the cord and reaches a neuron cell in the medulla (in the nucleus of the funiculus gracilis and cuneatus). This ganglion cell belongs to an intermediary ascending neuron. From it a crossing nerve fibre goes up to the optic thalamus and there arborises round a ganglion cell in this important collection of grey cerebral substance (*i.e.*, of ganglion cells). From this last-mentioned ganglion cell goes a third nerve fibre (reckoned from below) to some nerve cell in the cortex of the brain.

It is now necessary to add the presence in the spinal cord of small sensory "intermediary neurons" (Sehalt neurons), through which the sensory nerve fibres coming from the spinal ganglion cells in the posterior tract are connected with the centre for the peripheral motor neurons. With the centre for these neurons are connected also the ganglion cells in the cerebellum by means of their nerve fibres.

It is well to remark that the whole of this description refers to a structure of which future investigation will give us a more satisfactory explanation. The facts which I put forward here aim more at giving an idea of, than at really explaining the whole clearly, but an idea which, in the absence of a better, may be of some use.

The cerebro-spinal neurons are connected together by their *dendrites* and axons. A more central neuron is connected with a more peripheral neuron, in that the fine, root-shaped, branched end apparatus of one, resembling dendrites, embraces the ganglion cell of the other, and in some way transmits nervous impulses to the second cell. Such connections between neurons are known as *synapses*.

The white matter of the cerebrum, *i.e.*, its collections of nerve fibres, includes the system of coronal fibres which connect the grey matter of the cortex (*i.e.*, the ganglion cells) with similar cells in the mid-brain and the collections of grey matter in the medulla oblongata; we find here both cortico-fugal and cortico-petal fibres. We have further connections from the cortex with the pons and the cerebellum. In the pyramids we have nerve fibres to all the peripheral motor neurons. There are moreover fibres between the ganglion cells of the cortex, both between those which belong to the same side (unilateral) and those which belong to different sides of the body (bilateral), *i.e.*, connections by commissural fibres.

I would also remind the reader, concerning cerebral connections:—

that the *olivary bodies* contain part of the (motor) fibres from the anterior tract of the spinal cord, and also communicate chiefly with the cerebellum and with the optic thalami;

that the cerebellum (many multipolar ganglion cells) communicates with the centres in the spinal cord by sensory fibres in the lateral tracts, and with the brain by similar fibres in the crura of the pons and cerebrum, and through them with the frontal, parietal, and temporal lobes of the cerebrum, with the corpora quadragemina, and

through these with many of the smaller collections of grey matter in the cerebrum ;

that the corpora quadragemina are connected with the cortex of the cerebrum, with its internal grey matter and with the spinal cord, with the optic tract and with the motor nerves of the eye ;

that the optic thalami are connected both with the grey matter in the spinal cord and with the cerebrum, especially with the cortex, and also with the optic nerves.

The sympathetic nervous system is made up of a row of ganglia on each side of the spinal cord and of plexuses with their respective ganglia, found chiefly in the cavities of the body. Certain of its fibres are not white nerve fibres with neurilemma sheath, medulla, and axis-cylinder, as in the cerebro-spinal nerve-fibres, but plain grey fibres with an occasional nucleus.

The sympathetic nervous system possesses a certain autonomy, but is subject to, and closely bound up anatomically with, the cerebro-spinal nervous system. A good deal is still unsolved regarding the sympathetic nerves.

This system also consists of neurons, which may be divided into two different systems, of which the central represents the connection with the cerebro-spinal nervous system and really belongs to this system.

The neurons of the first (the *central*) system have their ganglion cells in the grey matter of the *spinal cord* (in the lateral horn), between the last cervical vertebra and the lower third of the lumbar cord. The "*spinal*" fibres ("preganglionic") go from the ganglion cells of the lateral horn of the spinal cord through the anterior roots, and *via* a *white* or medullated communicating branch to a (sympathetic) ganglion cell in a ganglion of the sympathetic chain, and either end round this ganglion cell in a root-shaped end apparatus or pass through it to some other ganglion, where they end round a sympathetic ganglion cell. This makes the cell station for the peripheral sympathetic neuron. From these centres go grey or non-medullated sympathetic ("post-ganglionic") nerve fibres by special grey rami communicantes to the spinal nerves and to the periphery, where they innervate the non-striated muscle fibres in the blood vessels, alimentary canal, uterus, etc.

The centripetal sympathetic neurons which probably exist are little known, but it is supposed that most of them go from the peripheral sympathetic centres to the ganglia in the chain, and from there through the posterior roots to the ganglion cells in the grey matter of the cord.

For every peripheral sensory neuron there is a certain minimal stimulus varying somewhat under different conditions, which just produces an effect, *i.e.*, a sensation ; this minimal effective peripheral stimulus is the German "*Reizschwelle*" ("*the threshold of stimulation*"). For an increase in the stimulation to be felt, according to the Weber-Fechner law, this increase must have a certain quantitative relation to the original stimulus (1 in 40 for tactile sensation in the hand, 1 in 100 for sensation of light). For the stimulus to reach the nearest central "*contact neurons*" it must be somewhat stronger ; the minimal stimulus necessary for this is the German "*Neuronschwelle*" ("*the threshold of neuron stimulation*").

During its passage through the nerve tracts the stimulus meets a certain resistance, which we take to be greatest where irritability, which varies in the different parts of the neuron, is least, and greatest of all where it passes from one neuron to another. The stronger the stimulus, the more effect does it produce and the more neurons does it affect.

The trophic condition of the neurons depends partly upon the stimulus to which they respond with their "*specific* energy" (sensation, movement, secretion, vascular contraction or dilatation), and in this respect there exists a sufficient stimulus, one too small and one too great. Further, the various parts of the neurons are trophically dependent one upon the other. If the nerve fibre is separated from its ganglion cell it degenerates (Joh. Müller); this is a useful fact, since with the help of the microscope we can use it for studying the anatomy of the nerve paths. If the peripheral area of activity of a ganglion cell is taken from it, its nerve fibre, with its end apparatus, degenerates (v. Gudden and others).

With regard to the speed of impulses in the nerve fibres, it is apparently both in sensory and motor nerves about 34 metres a second, and thus normally in no part of the human organism do they require more than a very small fraction of a second to travel their whole path.

The spinal cord forms, as we see from the above, and as every medical student knows, an organ not only for conduction, but also an intermediary station for centres between the periphery and the brain. These centres receive stimuli both from the brain and from the periphery, and, as they possess a certain autonomy, the *spinal cord forms specially an organ for reflex action.*

I would remind my reader that reflexes may also be sent out from ganglion cells higher than those of the spinal cord, and that particularly in the floor of the fourth ventricle there are reflex centres to be found.

By reflex action we mean the outcome or effect of every stimulus on a centripetal, *i.e.*, a sensory, nerve, which is thrown back from one or more nervous centres to the periphery. To stimulate a centrifugal motor nerve does not produce a reflex. As the reflexes are carried to the periphery by motor, secretory, and vaso-motor nerve fibres, they may also have motor, secretory, or vaso-motor effects. One jumps on hearing a shot, feels the mouth water on seeing a basket of strawberries, goes pale when one sees a tram run over a fellow creature, blushes with mortification over the sad phenomena of human baseness—all reflexes! (Personally I may say that when as a young man I came to know a little more physiology I often wondered if there were phenomena from the nervous system other than reflex action.) The physiologists, however, do not acknowledge the presence of *sensory* reflexes in the ordinary sense of the word, although it is true that a sensory nerve may conduct centrifugally. That perceptions may arise in a peripheral area on stimulating another peripheral area is explained by the expression "irradiation," etc. but is still *partially* unexplained.

I would remind the reader also of the presence of "*inhibitory reflexes.*" By stimulating the vagus (the central stump) the secretion from the pancreas may be made to cease. Other things being equal, the reflex from the depressor nerve of the vagus (Ludwig and Cyon), by means of which the mesenteric vessels are strongly dilated and the pressure,

particularly in the aorta, consequently markedly decreased, is also a vaso-constrictor inhibitory reflex.

We have classified and named reflexes chiefly after the easily observed reflex movements, and know that these arise according to definite laws, even when they are "irregular" (see below). With a weak stimulus a *simple* local reflex produces a jerk at the level of the place stimulated and in the same limb; with a stronger stimulation one sees that the reflex becomes double-sided and the jerk arises also at the analogous spot in the other half of the body. One sees that on extreme stimulation or increased irritability (produced by strychnine) the reflex becomes *widespread.*

Reflexes are involuntary, but some of them may to some extent—not always, and not always completely—be controlled (inhibited) by the will. If I am prepared for a shot to fall in my vicinity, by determination I am able to avoid starting.

It is the motor reflexes with contractions of the striated muscles under the power of the will which can be controlled by the will; our other reflexes can only be controlled by preventing the stimulus. Reflex movements of non-striated muscle fibres (especially vaso-motor reflexes) and secretory reflexes cannot be controlled.

By a careful study of our movements we arrive without difficulty at the conclusion, which is well worthy of attention, that between an entirely involuntary, simple muscle reflex and a fully conscious, voluntary and complicated co-ordinate, purposeful movement there are any number of intermediate forms. One particular argument for this opinion is the existence in the lower vertebrates of the extremely interesting so-called "*spinal mind of Pflüger.*" By this we mean the power that these animals possess, *without a brain*, of carrying on purposive, apparently conscious and deliberate, complicated co-ordinate movements. As the brain has been removed we must suppose that these movements are reflexes from the spinal cord, and call them by a special name, "*ordered reflexes.*" If after having cut out the frog's brain one waits until the animal has recovered from the worst shock of this severe operation and then pinches its hind leg, we find that it performs parrying movements with this leg or with the other hind leg. It can also sit, take ordinary swimming strokes, etc., all phenomena from its spinal mind. It is true that we human beings are able neither to parry, sit, nor swim after our heads have been taken off, and that our spinal mind is far inferior to that of the frog. But its presence in the frog, along with other facts, obtained from observations on lower mammals, allows us to conclude, not without satisfaction, that something similar exists in ourselves.

A fact to be inferred from the above-mentioned facts, of which every medical gymnast ought to be fully aware, is, as already mentioned concerning the various forces which decide the strength of our movements, that our motor apparatus consists not only of centrifugal motor neurons, but also of centripetal sensory ones.

What Bell called "*the muscle-sense*" is supplied really by sensory nerves from the skin, tendons, muscles, and joints. The nerves from the skin and their end bulbs indicate to us our various

movements and positions by telling us of the tension in the different skin areas; the sensory nerves in the joint capsules act in a similar manner; the sensory nerves from the tendons seem to be specially important for our realisation of the resistance to our movements, and the nerves of the same kind in our muscles tell us the degree of their contraction. In these last cases the end apparatus of deeper sensibility consists of "Pacinian" bodies (or Vater's corpuscles), and of "Krause's end-bulbs" (not Meissner-Wagner's).

To a great extent our positions and movements are controlled by the small remarkable organs in the inner ear, in certain parts of the "labyrinth." We must especially note the "semi-circular canals" which seem necessary, for the maintenance of our power of equilibrium, and for the performance of at least part of our own movements with the head (Mach, Breuer). New research and opinions are exceedingly interesting concerning the otoliths in the utricle and saccule, otherwise filled with lymph, the sensory cilia found there and our dependence upon all these structures (even upon the lymph) in taking our bearings in regard to the position of the head and in movements of progression. It is possibly in the labyrinth also that we must look for an important, so to speak peripheral reflex organ for the tone of the whole skeletal musculature (Ewald), which tone, according to modern opinion, does not depend upon automatic nervous activity, but upon reflexes. For further details of these conditions, which are still far from having been fully thrashed out, I must refer the reader to the larger physiological text-books and to special works on this subject.

I have already shown that if the information from these organs of deeper sensibility and from widespread areas of skin is broken off or becomes incomplete, our movements suffer both in strength and certainty; that, *e.g.*, if the posterior, *sensory* nerve roots of a dog are cut, symptoms arise which give an impression of true paralysis, in spite of the anterior motor roots being uninjured. In affections of the innermost parts of the ear spoken of above there arise giddiness and inability to maintain the erect position and to walk. In tabes dorsalis (= syphilitic degeneration in the posterior sensory tracts of the spinal cord) arise the swaying, uncertain movements already spoken of, dependent upon disturbances of co-ordination which makes up ataxia.

To some extent the sense of sight helps us in these cases, and as long as we are able to *see* our movements and positions we are better able to perform the former and to maintain the latter than when blindfold (Romberg's symptom = the inability of a tabetic patient to maintain the erect position with eyes shut).

The anomalies of the nervous system which come for mechano-therapeutic treatment, especially for medical gymnastics, differ widely in their character in regard to their pathological anatomy, clinical origin, and prognosis.

We treat by gymnastics both *central* and *peripheral* nervous diseases, *e.g.*, both tabes dorsalis and (the results of) acute anterior poliomyelitis on the one hand, and traumatic or rheumatic neuritis on the other. The anatomical changes in these, as in many other cases, are well known; some cases however of nervous disease (*e.g.*, hysteria) belong to the so-called functional neuroses, and we have no idea as to the underlying pathology.

The symptoms we desire to combat may be *hypotonic* or *hypertonic*. In the former we have *abnormally weak innervation*, as in *pareses;* in the latter *innervation is too strong* and causes tonic or clonic *spasm* (*cramp*). In other cases we find *irregular innervation*, as in the ataxy of tabes or in the tremors of occupation (co-ordination) neuroses.

All these phenomena may, especially in the functional cases, be found side by side. Hysteria may cause tonic blepharo-spasm or tonic muscular contracture in the elbow joint, or clonic spasm both in the sphincter of the eye and in the flexors of the arm; the patient sometimes has paralysis in these and other muscles, and is perhaps also much annoyed by tremor.

In other cases various symptoms belong to various stages. We have first hypertonic phenomena, when the nervous elements are subject in the beginning to severe irritation; by degrees and in proportion to the development of degenerative protoplasmic changes severe hypotonia and paresis arise.

How shall we explain the effects of medical gymnastics in these cases?

To begin with we rely on the fact that *the neurons depend for their nutritive condition on their activity;* they suffer equally from too much as from too little work. If we prevent too strong and increase too weak activity of the neurons, it is to be supposed that we shall affect them therapeutically. *We see then also that gymnastics, which exercises the neurons, has throughout much more influence upon hypotonic than upon hypertonic diseases; in the latter rest is generally the chief indication.*

We also rely on our knowledge of *the nutritive interdependence of the various parts of the neurons.* If we are able to restore to normal disturbed nutrition in a ganglion cell, we know that in this way we undoubtedly also restore to normal similar disturbed conditions in the corresponding nerve fibres and end apparatus.

Finally, we support our claim to therapeutic effect in this direc-

tion on our knowledge of the fact that *the nervous centres may be made to act vicariously for each other.* We do not know how this takes place; it is probable that an increased knowledge of the functions of the dendrites and the characteristics of development will assist towards greater clearness in these matters. It is perhaps partly upon the development of this substituting power of the neurons that our obvious advance in raising the power of co-ordination in ataxia by means of active gymnastics depends.

In the anatomical, physiological, and pathological conditions referred to above we find to a certain extent an explanation of the action of what the Germans, especially the mechano-therapeutists, call *assistive and resistive treatment.*

As our most important instrument in assistive as well as in resistive treatment we have the *will*, and it is only because we have daily evidence of this before our eyes that we often fail to give it its full value in hygiene as well as in therapeutics.

It is by active voluntary movements that in our earliest periods of life we begin to exercise our will, and we continue also throughout life to exercise it in this way, when the opportunities for its exercise are manifold.

It cannot be doubted that voluntary movements play a specially important part in the whole psychological development of the child. It is obvious that voluntary movements not only exercise the will of a young child, but are also valuable in developing his power of connecting cause and effect, his ideas of dimension, distance, time, etc., which facts, although not directly connected with medical gymnastics, are too interesting not to be mentioned here.

Another very important fact, which concerns medical gymnastics rather more, but also involves considerable intellectual, ethical and practical consequences, is that voluntary movements exercise a special kind of thoughtful and at the same time active *attention.*

By attention to our movements, especially those of the upper extremity, besides the educative gain of various kinds, we increase "*dexterity*," which is of great value for many different occupations, for artists and surgeons no less than for actual labourers and mechanics. Dexterity requires a clear consciousness of intention, well worked out in every detail, for each movement, the absence of all pathological disturbing influences (tremor, etc.), and a specially fine co-ordination which momentarily conveys to each muscle taking part in the movement exactly the amount of innervation most suited to attain the object of the movement.

It is a necessary part of my present task to emphasise the fact

that in all such finely co-ordinated, precise movements both the synergist *and antagonist* muscles taking part are undoubtedly innervated.

How the innervation of the synergist muscles and their antagonists behaves from a physiological standpoint cannot yet be said to be decided. H. E. Hering, Mann, and Sherrington are agreed that *at the same time as we send impulses to those muscles causing movement we send also inhibitory impulses to their antagonists.* In the opinion of many observers, however, this occurs to very different degrees, and O. Kohnstamm states that the ability of the practised workman to perform greater *external* work than the unpractised workman depends upon the former's unconscious exercise and skill in completely doing away with tone and innervation in the antagonists. Sherrington explained quite recently that in his experiments on apes in regard to flexion of the elbow joint he had never seen simultaneous contraction of the extensors. *It is, however, certain, as has been noticed by many investigators, that increased contraction of the antagonists of muscles performing certain movements takes place under certain conditions due to increased innervation.* In slow, carefully calculated movements one can clearly feel the firmness of the antagonists taking part, and we have good reason to suppose that innervation of these also takes place in every movement requiring specially careful co-ordination.

The influence of the will upon the activity of the neurons has only lately become more clear to human consciousness. Hypnotism and suggestion have shown how the will of *others* is able to control various kinds of sensibility, cause sudden amaurosis in a quite normal eye, produce anæsthesia in the most hyperæsthetic, hysterical patient, etc. We see also that strong-minded drunkards are able by means of a firm resolve and subsequent auto-suggestion to change both the smell and taste of their favourite drink from being pleasant to being repulsive to themselves. The will may stand in the same relation to the motor neurons. By will and the consequently increased muscle innervation we are able, when necessary, to increase suddenly the strength of our movements to an enormous degree, far over our usual ability; by will and the exercise of it in connection with movements we are able, as Exner expresses himself, to *assist* and *open up* movement neurons, and by will we can also *resist* and *repress* both certain reflexes and other expressions of sensibility.

In the assistive and resistive treatment there are also other means, partly mechanical, partly quite outside mechano-therapeutics.

E.g., it is possible to control the spasm of a choreic child by applying plaster bandages over the greater part of its body, and experienced

physicians are to be found who consider this the most effectual of the innumerable means used in the treatment of chorea.

There are other "internal" means. The attacks of cramp in strychnine poisoning may be controlled by large doses of chloral, which diminishes irritability, or by small doses of curare, which, without entirely paralysing, reduces strongly the activity of the muscle nerve-end plates. We can control the motor storms of the hysterical patient by administering bromide. We exercise an "assisting" effect upon the nerves by the electric current, constant or interrupted. We have also in strychnine an effectual "internal" means of "assisting" by raising irritability. But as soon as *any* impulse from the will reaches the muscles we have, both in the motor voluntary impulses and in the movements, as good a means of "assisting" as any other.

Assistive exercise treatment consists chiefly of gymnastics which we make use of to regain entire conductive power in the nerve paths where it has been more or less rendered difficult, i.e., specifically in pareses.

Assistive exercise treatment, as with all exercises, assumes *some* functional power, as the practice consists of a systematic exercise of the functions. Thus in *pareses* we are able to exercise the injured motor neurons which still possess a certain amount of functional power, and by degrees increase this power, while such exercises are excluded in complete *paralyses*. With apparently entirely destroyed functions it is of primary importance to stimulate them to some, if only the slightest amount of, activity. The methods which have shown themselves effectual in this contribute in a high degree in throwing increased light upon the physiology of nerves.

A common method in hemiplegia is to allow the patient to perform *at the same time the same movements on the affected as on the healthy side*. Swedish gymnasts call these movements "*double-sided*,"* *e.g.*, simultaneous extension in the knee joints of both legs. *Alternate movements also aid "assistive" treatment;* they also take place on both sides, but not simultaneously, *e.g.*, walking or eyeling.

The performance of movement "*at word of command*" is considered also assistive.

Many gymnasts first show the patient the movement, then perform it passively upon him, and then let him try to perform it actively.

Some give the word of command just at the moment when they

* P. H. Ling recognised our tendency to perform the same movements simultaneously with both sides of the body. He divided *involuntary* movements into associated movements, reflex movements, imitative movements, purposeful movements, and rhythmic movements. As the reader of physiology understands, all these kinds of involuntary movements are reflex movements except the ryhthmic (muscles of the heart and respiration), which can no longer be considered as such.

pass an electric current through the paretic group of muscles and its nerves. As improvement increases, the strength of the current is diminished.

Further we can make movement easier for the damaged nerve elements by letting the patient perform *the movement in a warm bath* (35° C., 15—30 minutes), *by which means the weight of his extremities is lightened by the mass of water displaced, so that he is often able to perform movements in the bath before he can perform them out of it.*

Persons who delight in learned expressions sometimes speak of the *kineto-therapeutic mirror.* With this one may practise both assistive and resistive treatment; *e.g.*, after infantile paralysis, by letting the patient practise in front of a looking-glass and observe himself one is able to exercise a strengthening influence upon the motor impulses of his will. Similarly, a patient with cramp of the muscles supplied by the spinal accessory nerve is able to control the attacks for a longer time in front of a looking-glass than without one, and thus obtains complete recovery more easily.

Resistive treatment is of use chiefly in hypertonic and irregular movement (*ataxy or tremors*), and is partially under the power of will.

One may, however, control the movements in two quite different ways. In the one case, and in hypertonic diseases, one represses the (*pathological hypertonic*) *innervation. In the other case, with irregular movements, one does not repress the innervation, but makes it stronger and more complicated, and what is impeded is only the speed of the movement.*

I have already given above a good example of true inhibition of motor innervation in a patient with cramp of the muscles supplied by the spinal accessory nerve, and who by will power (with or without a mirror and other means) attempts to control the attacks of cramp in these muscles (trapezius and sterno-cleido-mastoid), lengthens the intervals between the attacks of cramp, and by degrees causes them to cease entirely. Only in a definitely specified sense can such inhibition be reckoned as gymnastics, in that it aims at the maintenance of a certain (normal) position.

But, as already said, one may also control movements by innervating the antagonists of those synergistic muscles which perform the movement and in this way make the movement at the same time both slower and stronger.

In modern gymnastics we have two gymnastic systems which represent this method of control.

The "self-resisted" movements introduced by the brothers Schott at Nauheim into the treatment of heart diseases are per-

formed slowly during the keenest attention of the patient, and while he innervates both the synergists and antagonists so strongly that the whole of the external movement in comparison to the musele action beeomes a negligible quantity. Even the highest motor centres in the cortex of the brain are strongly exercised during these movements; they are supposed to have a specially strong influence upon the automatie centres, and in this way a strong collateral effect upon the motor centres of the heart. The Sehott exercises are used in organic heart disease, but are contra-indicated in neuroses of the heart. I will not take it upon myself to estimate their value; personally I have used instead Stokes' "terrain cure."

The movements of Frenkel's gymnastics for the ataxia of tabes are, in my opinion, self-resisted movements of a similar kind. These movements also are performed slowly with the keen attention of the patient, and while the antagonists of the museles are innervated; speaking physiologieally, these perform eccentric work. These resisted exercises of Frenkel are of great value in restoring a better power of eo-ordination, and in teaching the ataxic patient to manage his positions and movements with his diminished sensory resources, and they have very considerably helped to ameliorate his hard fate.

The treatment does not only aim at enabling the patient to perform normal movements, but also at correcting the faulty positions due to the widespread hypotonus. The inability of tabetie patients to *feel fatigue* must be taken into consideration in the treatment. This subject will be more fully dealt with in the special part of this work.

The self-resisted movements are the only ones which lend themselves to the treatment of occupation neuroses, and in my opinion only then after long rest from the muscle work whieh brought on the neurosis. Massage has here the preferenee.

* * * * *

Passive movements have a far less extensive physiological, and therefore also a far less extensive therapeutic, effect than active movements.

Passive movements eannot elaim any important value as regards the development and shape of the bones and skeleton.

The definite dilatation of the blood vessels in the muscles during aetive movements is not found in passive movements, and therefore the strong repletive and depletive effect upon the eireulation whieh active movements possess and the effect upon the nutritive eondition of the museles are done away with.

The passively shortened musele does not thieken as much as that

contracted actively, and does not press so firmly upon the veins as the latter. This factor in active movements, so beneficial to the circulation, is therefore less in passive movements.

Passive movements exercise the muscles only to a very limited extent. The muscle's power of stretching and elasticity are called into play, but it is not so in regard to its power to change by its own work chemically stored vital force into movement and heat. In resting muscle and in passively moved muscle, just as in other tissues, as we all know, an "internal" parenchymatous respiration takes place by which oxygen is taken up, carbon dioxide given off, and more complex molecules break up into simpler molecules with production of heat. But although metabolism in a passively moved muscle, owing to increased circulation (see below), must be somewhat more rapid than in a resting muscle, it certainly reaches only an inconsiderable fraction of the metabolism of an actively working muscle.

An interesting fact worth mentioning was, however, noticed by Schmulewitz, namely, that muscle, like elastic, becomes warmer to a certain extent on being drawn out.

By the absence of muscle work in passive movements the formation of those products which stimulate the centres for circulation and respiration is to a large extent absent, as also the consequent marked effect upon the activity of these organs. The enormous therapeutic effect of active movements, especially of "terrain cures" for weak hearts and other forms of cardiac insufficiency, is absent from passive mechano-therapy in so far as we aim at strengthening the heart. With regard to this I must allow that passive movements, by their effect upon the venous circulation mentioned below, *facilitate* the work of the heart. But this is quite another matter, and not nearly so valuable as *the therapy of exercise*, which by means of active movements can affect the heart itself. "*Chest-lifting*" is one of the movements most often used in Swedish gymnastics, and quite the most advertised as regards its effects. Nor can it be denied that it increases the ventilation of the lung—in other words, causes deeper inspiration and expiration, and thus has a similar effect upon respiration and circulation. But a fairly observant person receiving chest-lifting for, *e.g.*, a quarter of an hour, and afterwards walking uphill at a moderate pace for the same length of time, will obtain a vivid impression of the much greater effect of the walk than of the chest-lifting upon the ventilation of the lung, upon the heart-beat, systole and diastole, and upon the whole circulation for that matter.

From the above it is clear that passive movements only to a limited extent affect internal respiration, metabolism, and the production of heat.

It must be allowed, in spite of the lack of experimental evidence, that the effect of passive movements upon the tension of the fascia, upon the size of Braune's spaces and upon the "venous pumps," is much less than that of active movements. This very important difference depends chiefly upon the fact that *the muscles which act upon the fascia by their shortening in active movements owing to their power of contractility when influenced by the will contract strongly, but in passive movements they contract with considerably less strength.*

By the stretching of the veins, and by the compression of the blood vessels of the spleen, liver and other vessels of the abdomen during certain movements (see above), passive movements have certainly as strong an effect as active movements of the same extent.

Passive movements in medical gymnastics are of greatest value in the treatment of joint affections. By means of passive movements we can stretch shrunken joint capsules, ligaments and contractions, separate parts of synovial membrane which after long contact have become adherent to each other, as well as stretch or tear adhesions which have formed and other more or less organised inflammatory products. We thus prevent the changes which result from too prolonged fixation—shortening of soft parts, especially the troublesome atrophic shortening of muscle, formation of blood vessels and connective tissue, and finally adhesion and ossification of cartilage and consequent destruction of the joint. Lastly, by passive movements we can restore mobility of tendons and muscles which have become partially adherent to their sheaths as the result of prolonged uninterrupted rest or of inflammatory conditions.

On the other hand, stretching alone will not fully restore the length of a trophically shortened muscle. If one does not resort to orthopædics or surgery one must partially rupture the shortened muscles, treatment which is only possible in the case of the smaller muscles (see Muscle Contractures).

It is also worth noting that, with regard to contractures in the lower extremities, one ought not to spend too much time and work over passive movements. What these accomplish may also be *brought about by the partly active, partly, in a sense, passive, movements of walking,* and the patient will always prefer the pain caused by himself to that caused by others.

Passive movements form a part, along with active movements, holdings, massage and orthopædics, of the treatment of certain deformities, particularly of scoliosis or spinal curvature, which is extremely common. Active movements here aim at strengthening the back muscles, passive movements chiefly at stretching shortened ligaments and capsules and at mobilising abnormally immobile

parts of the spine. In the special part of this book I accentuate the necessity for less routine among gymnasts, whether medical or non-medical, that they may apply passive movements with the greatest care in order not still further to increase the deformity by too strongly "mobilising."

In regard to the nervous system, there is obviously a great difference between active movement, with its innervation of muscle, and passive movement, without it. Goldscheider and others, however, attribute to passive movements some "assisting" influence. If through paralysis or paresis the power of wrinkling the forehead or bending the elbow is lost, according to this idea one helps to restore this power by giving passive movements purely by opening up a nerve path. To distinguish as regards therapeutic value between active and passive movements in this as in many other matters is very difficult for those who cannot be said to have studied physiology.

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Gymnastic positions may be more or less active in character. A greater or less amount of static muscle work may go to their maintenance while other persons, apparatus, machines, or weights also work. In regard to muscle work, one may compare, for instance, the fundamental lying position, in which it falls to zero or to a real minimum according to one's idea of the position, with the hanging fundamental position, in which some arm, shoulder and neck muscles are active, and both these with leg-forward-lying position, in which strong and extensive muscle work takes place on the dorsal aspect.

The bones of the skeleton, since they form levers for static muscle work, are affected as to their form by the pull of the muscles *in the same way as by movements*, and most probably also receive more blood from their nutrient arteries (see below on Active Movements).

With fixation- and joint-apparatus position is also an exercise, especially when taken more accurately as a "holding," not merely as a starting-point for certain movements, and its greatest importance is as a means of stretching contracted joint capsules, ligaments, and other soft parts in cases of faulty position. Swedish medical gymnastics makes use of a great number of positions for the treatment of scoliosis; and among Zander's medico-mechanical apparatus, and other appliances since produced after his model, we find a considerable number which aim at maintaining certain positions with or without movements. We see more distinctly in this department than elsewhere how medical gymnastics touches orthopædics, as in other directions it borders on massage.

In the muscles working statically, innervated and contracted,

to maintain a position the small blood vessels are dilated as in active movements, and carry a richer flow of blood; more food substance is oxidised and more heat produced than during rest. Positions therefore have the same effect as active movements, as I have already pointed out, on the muscles themselves, on the distribution of blood, and, to some extent, on the heart and respiration, the centres for which are stimulated by the products of muscular metabolism. But those effects which in active movements are produced upon the venous circulation by the alternate thinning and thickening of the muscles and by the lengthening and shortening of the blood vessels, as well as by the increase and diminution of Braune's spaces, and in some cases by compression of the liver and spleen, are excluded from static muscle work. Because the blood flow in the vessels and towards the heart is less, and because the products of metabolism which excite the circulatory and respiratory centres reach the circulation less quickly in positions than in movements, the former have less effect than the latter on circulation and respiration. *Because the fatigue products are carried away from the muscles less quickly in static than in motor work, the former produces comparatively greater fatigue than the latter.*

It is manifest that the nerve elements belonging to the motor apparatus are exercised by positions as well as by movements. By careful attention to position some of the effects described above for self-resisted movements may be produced. And although positions are not so much used as movements in Frenkel's compensatory exercise treatment, they are an essential part of this important branch of gymnastics. One cannot doubt that a tabetic patient by standing with eyes shut trying to control Romberg's symptom, in other words to maintain his balance, is exercising what remains of the corresponding sensory neurons in his spinal cord and cerebellum, *i.e.*, his co-ordinating mechanism, or that by standing on one leg with eyes open he is exercising his power of replacing lost sensibility by the sense of sight.

CHAPTER VI.

POWER OF WORK—TEST OF WORK UNDER-WORK—NORMAL WORK—OVER-WORK AND STRAIN.

In the preceding chapter we have seen that the power of a muscle for work, other things being equal, is in direct proportion to its thickness, but also that other things never are equal, and that in all power of doing work, especially for a long period, there are many other factors than the muscles. The conditions, especially of the circulatory and respiratory apparatus and of the nervous system, play important parts. Incidental conditions have also a great effect. Purely intellectual or psychic strain, depression, sleeplessness, fasting, losses of blood or anæmia from other causes lower the power of work. Work performed by separate muscle groups has to some extent a fatiguing, *i.e.*, a force-diminishing, effect on the other muscle groups (Mosso, Maggiora, Adduco, Treves, Horwath, Brandis, and others). Lastly, *practice* has a very great influence, although it is possible and perhaps probable that the difference between equally thick practised and unpractised muscles is not in their force, but merely in the external expression of their work (see below). Comparative *test of strength* must therefore be minute, must be repeated several times, and must be concerned with both *strength for the moment and power of endurance ;* of which more below.

The *absolute strength* of an individual is represented by E. F. Weber as the lowest weight that the individual quite fails to lift.

There are different instruments and methods for other tests of strength, most of which are concerned with the upper extremities, and are performed with apparatus constructed after the principle of Mosso's *ergograph*, designed for the fingers. The test is performed in such a way that the person tested lifts certain weights in a certain time, while a graphic representation is obtained in the usual way showing the height, time, and number of the liftings. Generally a higher work value is obtained in a certain time by lifting smaller weights quickly than by lifting larger weights more slowly (Stupin) ; on the other hand, to obtain the maximum work value one must make use of a certain weight value. By diminishing the weight lifted at a certain time-rate till the individual at that rate can go on lifting the weight for an indefinite time without

diminishing the height of the contraction, one obtains, for that individual, the "*final maximum weight*" (Treves) with which he can work, as we all work with the heart and respiratory muscles.

If the weight or the rate of lifting is increased, by degrees *fatigue* (see pp. 44, 85, 86, 93, 114, 119) arises and shows itself by *diminished functional power* (= weaker contractions) in the muscles, and by the *feeling of fatigue*, probably produced through their sensory nerves.

I will remind the reader that extreme over-strain can entirely destroy for the moment the power of the muscle to contract under the influence of the will, and that fatigue lasts much longer if it is driven to extreme (Maggiora); that this is probably accounted for by the collection of "*fatigue products*," and by a lack of supply of those substances which are consumed during muscle contraction. A *dissected* muscle which has been fatigued by electrical stimulation will recover to a certain extent after a short rest, and the recovery is less complete the less oxygen there is in the atmosphere surrounding it.

Further, we know definitely that the ganglion cells are the first parts of the neurons to tire, that after them probably the muscle end-plates are overcome by fatigue, but that the nerve fibres may receive millions of stimuli without any functional disturbances arising in them (Mosso, Bernstein, Wedenskij, Langendorf, Bowditch).

By *practice* one can increase one's strength and the external effect of work, as is easily understood. By exercise the muscles undergo a work-hypertrophy, and a thick muscle, other things being equal, is stronger than a thin. For this reason a practised worker is specially competent in his special work, since the muscles which are exercised in this work are those which hypertrophy. But this does not explain all the facts in regard to the effect of practice. It takes a long time to develop a work-hypertrophy, while by exercise one can increase one's power of work in a comparatively short time; an unpractised individual in a few weeks can by practice double his daily work. For this reason the difference in power of work between the unpractised and the practised worker is very much greater if one compares moderate work done for a long time rather than maximum or great efforts in a short time. While an unpractised but stronger person can produce a greater work-effect in a quarter of an hour than a practised but weaker person, the latter has a better prospect of excelling in a longer period of work, therefore especially in the question of a day's work. The difference is due to some extent to the power of the practised worker to perform with his arms and implements the

movements most effective for his special work; this difference affects the simplest work. But other factors are also concerned, and there is a little series of phenomena which are worth considering, and which perhaps are all explained in the same way. Leo Zuntz states that metabolism during work (cycling) is greater during fatigue, other things being equal. Johansson and Koræn also observed that the production of carbonic acid is greater towards the end than in the beginning of long-continued muscular contractions. Schnyder found that a sick person or convalescent consumes more than a healthy person for the same work. Possibly the condition observed by Zuntz and Schumberg that work is more expensively performed (*i.e.*, with greater metabolism) in excessive heat than at a cooler temperature has the same explanation.* *It may be supposed that all these facts depend upon the varying inhibition of innervation of the antagonists of the working muscles discussed by Kohnstamm, and that one who is tired, ill, or working in great heat loses something of his power to completely inhibit the innervation of the antagonists.*

This explanation of the above-mentioned phenomena does not damage the probable hypothesis that every calorie consumed within the organism gives the same work value, and that only the external expression of work changes; it seems for the present, therefore, to be the most plausible.

For every individual there is a day's work, varying within certain limits, which is his normal work, and which is an essential condition of the maintenance of his healthy functions and general well-being. I would remark in passing that such normal work does not exclude, but probably rather causes, a moderate daily fatigue.

Work which is short of this very varying amount for each individual is *under-work*, and in the long run produces functional changes and illnesses which at all ages are much commoner phenomena than the results of over-strain. *A child living a sedentary life suffers in his whole psychical and other development, is especially weak in muscle, weak in heart, weak in nerve, anæmic and delicate throughout. An adult leading a sedentary life shows similar symptoms, readily falls into "apathy," is an easy victim to neurasthenia, obesity, gout or diabetes, suffers from hæmorrhoids, constipation and more or less definite symptoms in connection with nearly all the systems of the body.*

In contrast to the results of a too inactive way of living stand the results of *over-work*, which results we group under the term *over-strain*, acute or chronic. It is, as already mentioned, a some-

* Other writers (Marey, Edwards, Gad and Heymons, Carovallo and Weiss and others) find that a temperature of about 38° C. is the most favourable for muscle work in man.

what rare phenomenon, and, at least in Sweden, is especially rare among physical workers. Acute over-strain seems to be commonest among troops on the march and in enthusiastic sportsmen; the chronic form (in time of peace) is most often met with in the latter.

Under the term "physical over-strain" one might include all pathological phenomena produced by too extensive, too strong, or too long-continued physical work. The term would then include many conditions which arise in a purely mechanical way. One might, for example, reckon among the results of over-strain dilatation, rupture, or paralysis of the heart, dilatation or rupture of blood vessels, rupture or over-strain of muscles, hernia, sprains, dislocations, and even certain fractures.

In speaking of acute and chronic physical over-strain the physician seldom thinks of any of the above conditions, except those which directly concern the heart muscle and nerves. Otherwise the clinical picture of over-strain which rises before him includes many symptoms, many of which are certainly of a mechanical nature, but most of which, especially in acute over-strain, have chemical causes, and to some extent show an unmistakable likeness to purely toxic symptoms. Without paradox one may support the view that physical *over-strain is partly an intoxication*, which is explained by the fact that moderate physical work, like certain substances, has an exciting effect, while excessive effort, like the same substances in larger doses, produces symptoms of depression. A quick and not too long walk has a slight exciting effect, which by its influence on the heart, on respiration, on the mind, on the feeling of strength, and on the whole nervous system acts in a very similar way to other forms of excitation; after forced marching marked depression arises.

The symptomatic picture of *acute strain* varies much according to the intensity of the physical exercise.

Short, violent strain is known chiefly by symptoms from the heart and respiratory apparatus; these show themselves before symptoms of muscle fatigue become marked.

If, *e.g.*, some one climbs a small incline quickly, when he arrives at the top he suffers chiefly from *dyspnœa*. The respiration is "panting," its speed as much as twenty or even thirty a minute, the volume of inspiration and expiration almost reaches the amount of the vital capacity, and all the respiratory muscles are brought into play.

It is doubtful whether even in this state of things the blood in the veins of the systemic circulation is more rich in oxygen than usual (see p. 120). For if we examine the heart we find that the

right side especially has been over-strained by doing the increased amount of work necessary.

The breadth of cardiac dulness is increased as a result of the inability of the right ventricle to complete systole, and of its distension by blood. The pulse is quick, small, and not seldom uneven, while an occasional beat is absent. On continued examination, while the test patient recovers from the strain, one is able to estimate how the cardiac dulness diminishes in breadth, and how the pulse by degrees becomes fuller and more even, in proportion as the panting respiration and the pulmonary circulation return to normal and the left ventricle receives a full blood supply. In a strong normal individual such a slight excess is followed by no continued injurious results. But violent strains, relatively or absolutely too great, may produce *dilatation*, with incompetence and other results. *Rupture of the heart*, which may be fatal immediately or only after a day or two, or *paralysis of the heart* are not unknown phenomena after such excesses.

After somewhat less intensive, but more continuous and severe, physical exercise, for example after many hours' walking, there arise in acute over-strain lesser symptoms from the circulatory and respiratory apparatus than those of fatigue, with accompanying symptoms from muscles and nerves.

After excessive work one finds in the tired muscles, *e.g.*, the leg muscles after forced marches, a condition which strongly resembles acute myositis. They are the seat of spontaneous pains, are tender on pressure, and on palpation they seem doughy and swollen and of diminished elasticity. There is little doubt that the *marked hyperæmia* of the motor apparatus after too severe strain may cause inflammation. *Many doctors consider that both acute myositis, acute teno-synovitis, and acute synovitis may be the result of such excess.*

Modern neurologists—I am thinking particularly of Oppenheim—express the same opinion with regard to *neuritis*.

It is after such fatigue that we often find a slight temporary albuminuria.

Tremor and *cramp* in the over-strained muscles are common symptoms—after marches particularly *gastrocnemius cramp*.

When fatigue becomes extreme it spreads by degrees to the cerebro-spinal nervous system. Movements become weak and uncertain; the temporarily increased psychic irritability gives place to *loss of will-power* and *sluggishness*, and finally the patient falls into a deep, heavy sleep.

Chronic over-strain also is easily felt by the heart, skeletal muscles, and nerves. But there are besides disturbances in the general nutrition.

We find two common affections of the heart in such cases—*hypertrophy*, with or without previous dilatation, and *cardiac neurosis*, both most common among certain classes of sportsmen.

In the skeletal muscles we find also two affections—*atrophy as a result of over-strain*, and *occupation or co-ordination neuroses*. Both arise as the result of one-sided muscle work, *i.e.*, continuous excessive work for certain groups of muscles.

Atrophy due to over-strain is rare; it may sometimes arise in labouring men, but more often in sportsmen. A weaver, who extends his arm 20,000 times a day, gets atrophy of triceps (Oppenheim); Lennmalm in Stockholm observed atrophy of the right calf muscles in a sleighing amateur using the long, narrow light sledge used in Scandinavia, propelled in the same way as a child's scooter.

Co-ordination or occupation neuroses with tremor, spastic, or paralytic symptoms from the over-strained muscle groups are far more common (in writers, pianists, dancers, etc.); all of us with experience have seen many of these.

Continued excess of more widespread muscle work causes the more or less developed picture of *neurasthenia*. Such patients are often very *anæmic*, and often show considerable *loss of flesh* below their normal weight.

CHAPTER VII.

CONTRA-INDICATIONS TO GYMNASTICS.

MEDICAL gymnastics includes movements which vary from the most careful passive movements in a single joint (for contractions in the same) to the extensive severe marching of "terrain cures" (for obesity). With a reminder of this and of the need for discrimination in estimating the value of the contra-indications, which must be left to the reader, I introduce what follows.

We must first notice three general conditions and diseases which often contra-indicate gymnastics, especially all extensive movements :—*severe diseases of various kinds accompanied by great weakness, all fevers, all acute inflammations, particularly in the parts of the body taking part in the movements.*

It goes without saying that the *extremely exhausted patient*, for example, a case of Bright's disease in the last stage, a very anæmic person, an advanced case of diabetes, ought not to be subjected to (medical) gymnastic treatment.

The febrile patient is also excluded from such treatment as a rule, partly on account of his mental sensitiveness and need of absolute quiet, partly because extensive physical exercise causes an increase of temperature.

Acute inflammation in its various forms contra-indicates movements in that part, because these increase hyperæmia and thus help to keep up the inflammation. In all times rest has therefore been considered an excellent "antiphlogistic." All extensive purulent processes are absolute contra-indications, and even all purely serous ones. In a recently sprained ankle modern treatment, to be complete, consists of ice-bags, raised position, effleurage, and complete rest until the more acute stage of inflammation is over. This applies also to all extensive acute catarrhs, *e.g.*, gastro-enteritis.

On the other hand, inflammations which are quite chronic do not contra-indicate gymnastics. We do not place chronic rheumatic groups of muscles at rest, nor forbid movements in the joints where fluid is present, or with the common localised infiltrations in the capsule (known in Sweden as "capsulitis"), dry crepitating arthritis, chronic catarrh in the alimentary canal or air passages, etc.

Just as many morbid conditions and processes in the circulatory

organs, especially in the heart, are beneficially affected by gymnastics, so there are other allied diseases of the *heart and blood vessels* in which extensive or strong movements are harmful, perhaps even immediately dangerous to life. Many of these conditions are hard to diagnose, or at least to estimate at their proper value, and it is one of the most difficult duties of the practitioner to judge rightly in these cases, and to state in a special case whether all gymnastics is contra-indicated or whether, and in what form, it should be used.

One may assert that *all acute heart affections*, serous, " plastic," ulcerous and purulent, endo- and peri- carditic processes, and even acute neuroses of the heart, forbid all gymnastics.

One may further assert that in *extreme cases of morbid change* resulting from such processes there is no prospect of improving the heart's action by means of active gymnastics, and that all active movements, beyond those which are necessary for a daily life as quiet and methodical as possible, carry with them the danger of rupture, hæmorrhage, renewed inflammation, emboli, etc.

Among such conditions we include *extreme degrees of valvular disease, extensive adhesions between the visceral and parietal layers of the pericardium, the latest stages of fatty degeneration of heart muscle, changes in the myocardium due to severe pericarditis and endocarditis, or long-continued febrile disease, before nature's repairing work is completed, advanced arterio-sclerosis, especially in the coronary arteries, above all, large or small necrotic areas, depending upon the latter, generally found near the heart's apex* (*Ziegler's myomalacia*), *also aneurism of the heart.*

The only medical gymnastics which can be considered in these conditions are *passive* movements which specially help the circulation and more especially the return of the systemic venous blood to the heart, and moderate walking on level ground.

For the rest I would refer to my account of the treatment of heart disease by " terrain cures " in the latter part of this book.

In *pure neuroses of the heart* we generally exclude all movements which greatly increase the heart's action, that is to say, all brisk and extensive active movements. One must, however, take this contra-indication with great discrimination. If a heart neurosis has been produced by excessive physical exercise, we forbid those special exercises. But those leading sedentary lives who suffer from palpitation of the heart, with irregular pulse and other marked and troublesome, though often subjective, symptoms, often feel much better or are completely cured by physical exercise, which should be taken in such cases during those hours when the heart is regular. Most of these patients suffer from their symptoms only

during part of the day or night. I have repeatedly had good results in such cases from systematic "terrain cures." There is scarcely anything in the way of exercise which more often produces neuroses of the heart than excessive cycling. On the other hand, a distinguished nerve specialist among my Swedish colleagues maintains that he is free from palpitation whenever he takes a vigorous cycle ride daily.

Among heart neuroses I include *Basedow's disease*, and especially those cases of partially developed Basedow's disease which we see much oftener than the developed disease, and in which the tachycardia and nervous symptoms without exophthalmos lead us to discover the only slightly apparent swelling of the thyroid gland. In these cases no movement with the slightest strain is permissible.

All conditions of the vascular system in which there is danger of hæmorrhage contra-indicate extensive movements which raise blood pressure in the vessels. Apart from arterio-sclerosis I am thinking now of "open" ulcerous processes in the lungs in phthisis, in gastric and duodenal ulcer, etc. To order gymnastics in a case of definite aneurism should be a matter of legal responsibility. In regard to varicose veins, see the chapter on "Terrain Cures."

All conditions of the vascular system in which there is danger of embolus are a decided warning against brisk or prolonged movements, and we are always anxious in cases of venous thrombosis to ensure the most complete rest possible for the patient until it has "consolidated."

Neuro-muscular affections associated with hypertonicity, i.e., with a continuous morbid increase of muscular activity, in the form of tonic or clonic cramp, spasm, tremor, etc., contra-indicate movements and indicate resistance treatment. On this subject views differ widely. In *chorea* the complete resistance treatment by means of immobilisation has its devoted adherents. In the *co-ordination occupation neuroses* we ought undoubtedly to exclude all gymnastics, and in mechano-therapeutics make use only of massage. On the other hand, there are many doctors and more "specialists" who would include self-resisted movements, in which the patient tries to regain control by performing the movement with great attention and quite slowly. Meanwhile it cannot be far from the truth to assert that *all morbid conditions which are the result of over-strain or produce strain on movement should at first be treated by rest, especially of the directly over-strained parts of the motor apparatus, and from those movements which have caused the over-strain.* For the rest I would refer to what is said above on over-strain; all the pathological conditions arising from it contra-indicate active gymnastics.

The motor apparatus in order to be exercised must be free from some of the more important changes and conditions, most of which preclude gymnastics on account of acute inflammation, as already mentioned, or on account of the necessity of immobilisation for healing to take place. Recent fractures or dislocations, sprains and bruises, osteomyelitis, and tumours of bone, prevent physical exercises.

Gymnastics is contra-indicated by various conditions and processes which also contra-indicate massage.

Strong or extensive movements are dangerous in certain conditions in the abdominal cavity. Apart from gastric or duodenal ulcer, which have already been mentioned as causing danger of hæmorrhage, *ovarian cysts and other tumours, hydatid of the liver, hernia, etc.*, must also be mentioned.

Stone in the pelvis of the kidney or bladder, as well as large stones in the gall-bladder, contra-indicate *violent* exercises.

The same is the case with *pregnancy.*

Certain *poisons* are absorbed more quickly and produce more severe effects during movement than during rest, whether they are taken in by the mouth or (as in snake-bite) by the skin.

Physical exercises, owing to their exciting influence, are contra-indicated in the *various forms of psychic exaltation.*

* * * * *

CHAPTER VIII.

STANDING POSITION AND WALKING.

In *standing* the line of gravity falls inside, and as nearly as possible through the centre of the *supporting surface*. This surface is bounded posteriorly by a line drawn through the tuberosities of the os calcis, anteriorly by a line through the heads of the metatarsals, and laterally (under normal conditions) by lines drawn from the head of the fifth metatarsal on each side to the tuberosity of the corresponding os calcis. *The centre of gravity of the trunk* falls, with very slight variations, within the thorax in front of the tenth dorsal vertebra,* and equilibrium is easily maintained in different positions by means of small movements in the spine and extremities.

The erect position, with more or less extended spine, and with the hip, knee, and ankle joints fixed, is maintained partly by muscular action, partly by means of mechanical arrangements designed to economise this action.

Let us now consider *the position of a person standing on both legs with the weight of the body equally distributed between them.*

In an *easy standing position* the centre of gravity of the trunk falls behind the transverse axis of the hip joints. The weight of the trunk acts on the pelvis in the region of the promontory of the sacrum. The posterior part of the pelvis is rotated downwards, the anterior part upwards, so that the lower extremities are fully extended at the hip, or, in other words, *the pelvic tilt* † *is reduced to its minimum.* The stretching of the ilio-femoral ligaments to the maximum causes the minimum tilt to be reached before the pelvis has rotated too far backward, and it is generally held that the

* The centre of gravity of the body as a whole is situated in the second sacral vertebra.

† By pelvic tilt is meant the angle between the horizontal plane and a plane through the upper aperture of the pelvis, or that plane which passes through the upper edge of the symphysis pubis, the ilio-pectineal line, and the promontory of the sacrum. This angle varies considerably, and is smallest in an easy, greatest in a forced, standing position. It depends also on the position of the legs, because the distance between the points of attachment of the ilio-femoral ligaments varies with different degrees of extension or flexion, abduction or adduction, rotation outwards or inwards of the hips. This distance is least when the thighs are neither rotated outwards nor inwards and are abducted to form an angle of 20° with one another. In this position the ligaments are least stretched, the pelvis can most easily rotate backwards, and the pelvic tilt can reach its minimum of 40° or 50°. The inclination commonly varies between 60° and 65°. By rotation outward or inward, combined with abduction or adduction and a fully extended position, the pelvic tilt can reach its maximum of about 100°.

flexors need not come into action at all to fix the hips in an easy standing position. Since the line of gravity falls far back in this position, we stand with knees slightly bent and with feet somewhat dorsally flexed in order to bring the line inside the supporting surface.

In a *strict military standing position* the tilt of the pelvis is greater, the upper part of the body is inclined forward, the concavity in the cervical and lumbar regions of the spine is increased, the convexity in the dorsal region is decreased. The centre and line of gravity are moved forward, so that the latter in some cases may fall in front of the transverse axis of the hip joint. The lower extremities are fully extended at the knee, and their axes fall vertically downward and sometimes a little forward from the hip joints. The ilio-femoral ligaments are not stretched, nor are the hip joints extended, to the maximum, but their extensors must work to a certain degree to prevent flexion and a falling forward of the trunk.

Except in a forced position the line of gravity falls somewhat behind the transverse axis of the knee, and the weight of the body, though working with very short leverage, tends to cause flexion. Dalla Rosa * considers that in an *easy standing position* flexion is entirely or almost entirely prevented by the mechanical structure of the knee joint, for, the articulating surface of the inner condyle of the femur being longer than that of the outer, the femur is rotated inwards when the knee is fully extended with the foot and leg fixed. But flexion cannot take place in the knee until this rotation has been overcome, and, as the ilio-femoral ligaments are stretched and prevent outward rotation, gluteus medius and minimus must be innervated to produce this action. In my opinion, however, the knee, though very nearly, is not *fully* extended in an easy standing position, and I believe that one must bring quadriceps femoris into play to prevent flexion even in this position. This conclusion is arrived at by palpation of this muscle group. In this palpation, as in all other kinds of examination of muscles, it must be remembered that there are all possible intermediate stages between complete muscle relaxation (as under chloroform), or the weak muscular tone of a comparatively inactive muscle on the one hand and a muscle in a state of the strongest possible contraction on the other.

* Of modern writers who have thoroughly discussed walking, Dalla Rosa most deserves study. With regard to the mechanical and dynamical details relating to this subject, I have in my comparatively short essay generally followed Dalla Rosa's most valuable treatise, but nevertheless I differ from him on some points. To a somewhat greater extent do I differ in regard to the question of the general motor forces in walking. On this point Dalla Rosa's view seems to me a paradox; in any case, his way of formulating his ideas is likely to give rise to totally false impressions.

In a *strict military standing position*, when the knees are fully extended and extension maintained and simplified both by the line of gravity being moved forward and by the inward rotation of the femora, one can easily prove for oneself that quadriceps femoris again comes into action.

In any standing position, whether easy or forced, the weight of the body is borne by the lower tarsal joints and is transferred from them to the tuberosities of the os calcis rather than to the heads of the weaker and longer metatarsal bones. The line of gravity falls slightly outside the almost sagittal axis of the lower tarsal joints, and so tends to cause eversion of the foot, or if the foot is fixed on the ground causes the axis of the leg, reckoned from the ankle, to have an outward direction. This eversion becomes greater the nearer the feet are to each other, but it never becomes excessive, since the legs are fixed just the right distance apart at the hip joints. The line of gravity, the resultant of the equal weights resting on the two legs, generally falls just *in front* of the axes of the *ankle joints*, *i.e.*, the legs have a forward direction from the ankle joint and form an angle of about 7° with the vertical. The ankle joints are fixed in position by the plantar flexors, especially gastrocnemius and soleus. But these muscles have to work but little, as muscular activity is again economised by the mechanical structure of the joint. This is such that while the axes of the ankle joints converge somewhat forward, the planes of dorsal flexion diverge somewhat outward, so that as long as the knees are more or less fully extended it is impossible for dorsal flexion to take place in both ankle joints at the same time. Further resistance to excessive dorsal flexion is caused by the broad anterior portion of the upper articulating surface of the astragalus, which prevents the corresponding articulating surfaces of the tibia and fibula from gliding far forward, since this would necessitate some separation of these bones and stretching of the ligaments between them.

All that has been said up to this point refers to a symmetrical standing position in which both legs share the body weight equally. In an easy standing position, however, we often support ourselves on one leg only. In this case the lower tarsal joints of this leg come into a position of maximum eversion, and the plane in which flexion in the ankle joint takes place, instead of being directed forward and outward, is directed straight forward or even forward and inward. The supporting leg is directed upward and outward from the ankle, is fully extended at the knee, and is fixed in the adducted position at the hip, and the upper part of the body forms an angle with it at the hip to prevent the line of gravity from falling too far

out. The other leg may be placed in many different positions, and is used merely to maintain balance.

When we begin to *walk* we bring the foot of the supporting leg into a position of abduction in the lower tarsal joints by innervation of the muscles which evert the foot, this eversion being combined with a certain amount of dorsal flexion in the ankle. As a result the astragalus is rotated somewhat inward, and the axis of the ankle joint, which was previously directed inward and forward, becomes transverse, or is even directed backward and inward. When the lower leg is dorsally flexed at the ankle the flexion is not forward and outward, but straight forward, or even somewhat forward and inward, so that the line of gravity is easily transferred when the other foot becomes the supporting foot. The knee of the supporting leg is kept extended, whereby the inward rotation of the femur is somewhat increased. The calf muscles come slightly into play to control dorsal flexion at the ankle.

Simultaneously an impulse is sent to the abductors of the hip joint of the supporting leg, gluteus medius and minimus, which, as the foot is fixed on the ground, rotate the pelvis on its sagittal axis and so raise the hip of the moving leg. In order to maintain balance and prevent the line of gravity from falling too far out on the side of the supporting leg the extensor muscles of the back on the opposite side are brought into play, and the line of gravity then falls within the supporting surface.

In abduction the distance between the points of attachment of the ilio-femoral ligaments is shortened and the ligaments become lax, but are stretched again because the heavier part of the pelvis behind the hip joint rotates backward and the joint thus becomes further extended. As a result the moving leg, as soon as it is lifted from the ground, is carried forward quite independently of any flexion at the hip joint. The lifting of the foot from the ground on this side is not only brought about by the rotation of the pelvis on its sagittal axis, but even by the innervation of the long flexors of the knee (semi-membranosus, semi-tendinosus, and biceps) and by the flexion of the knee. A slight inward rotation of the leg accompanies this flexion, so that the foot has an almost sagittal direction.

In this way a change from standing to walking has been effected. *In walking the centre of gravity of the body is continually being moved forward, and is first on one side of the sagittal plane and then on the other, each leg alternately providing support. This action of walking we divide into steps, and every step may be considered as consisting of three almost equal periods. An average step is* 66 *cm. and lasts* 0·6 *second.*

With Dalla Rosa we may arbitrarily number the periods of a step in the following way :—

The first period lasts from the moment when the hanging and swinging leg has reached the vertical position and is in profile with the supporting leg to the moment when the heel of this hitherto swinging leg touches the ground.

The second period includes the time during which both feet touch the ground, however small the surface in contact.

The third period lasts from the moment when the posterior leg leaves the ground and becomes the moving leg to the moment when it reaches the vertical position in profile with the supporting leg.

During the first period the *supporting leg* with extended, or almost extended, knee performs a dorsal flexion at the ankle. At the same time the hip is extended to its maximum the abduction remaining in this hip from the standing position is overcome, and the pelvis rotates, at the hip of the supporting leg, on its vertical axis, so that the opposite hip is carried considerably forward. This movement is performed by the anterior portions of gluteus medius and minimus.* Dorsal flexion at the ankle, which up to this point has been straight forward, is now directed slightly inward, and the supporting leg rotates slightly outward, having previously been rotated a little inward. These changes in movement are due to the marked inversion in the lower tarsal joints which now replaces the preceding eversion. As the supporting leg leans farther forward the calf muscles are innervated to control the movement.

At the end of the first period when the heel of the *swinging leg* first touches the ground the ankle joint is slightly plantar flexed, the knee almost straight, and the hip somewhat flexed. The forward and inward rotation of the pelvis on the vertical axis of the hip of the supporting leg is compensated by the outward rotation at the hip of the swinging leg, so that the foot is directed straight forward.

At the beginning of this period the pelvis was higher on the side of the moving leg than on that of the supporting leg ; at the end of the period the opposite is the case. *During this period the pelvis as a whole, the upper part of the body and its centre of gravity have been lowered and have fallen somewhat forward, and the centre of*

* In this connection I would mention that gluteus maximus is essentially an extensor of the hip and only a weak abductor and outward rotator, that gluteus medius as a whole abducts, that its anterior portion rotates inward and flexes and its posterior portion rotates outward and extends, and that gluteus minimus has a similar effect, but is especially an abductor and inward rotator. Gluteus maximus comes strongly into action in hill-climbing, comparatively little in ordinary walking. The other two, on the contrary, are very active in walking, since they help to rotate the pelvis on its vertical axis and to fix it to the supporting leg in the third period.

Tensor fasciæ latæ is a flexor of the hip. During flexion it works with ilio-psoas, and by its power of inward rotation counteracts the outward rotating effect of the latter muscle.

gravity has passed the medial sagittal plane and lies over the forward foot. The movement has been carried out chiefly by means of gravity, and the muscles have controlled and directed the momentum so acquired.

The outward rotation of the swinging leg during the first period is performed by the posterior portions of gluteus medius and minimus. Flexion of the hip is produced principally by ilio-psoas, helped by the adductors, which are also to a certain extent flexors. Both ilio-psoas and the adductors aid outward rotation. The almost complete extension of the knee which occurs at the end of the first period is ascribed by Dalla Rosa to the *vis inertiæ* of the mass movements, assisted somewhat by tensor fasciæ latæ, but for my part I consider that quadriceps femoris is especially active here.

The second period during which both feet touch the ground begins when the heel of the hitherto moving leg first reaches the ground. This leg, as already stated, is slightly plantar flexed at the ankle, extended at the knee, flexed and rotated outward at the hip. The foot of the posterior leg in many cases rests even at this point with the whole sole on the ground, is inverted at the tarsal joints, and dorsally flexed at the ankle ; the knee and hip are fully extended, the hip at the beginning of this period standing a little higher than that of the other side. The rotation of the pelvis on the vertical axis of this hip has carried the other hip joint strongly forward, but the trunk has compensated for this by rotating in the opposite direction and is turned straight forward. The energy of the mass movements is checked by placing the foot on the ground (and is thus converted into heat), but is still present in the parts above the feet, and is greater in the parts farther removed from the feet. *The centre of gravity during the second period also moves forward, but before the end of the period, at least in many cases, the upward movement begins, which however really belongs to the third period.* The tarsal joints of the anterior foot now succeed the corresponding joints of the posterior foot as centres of the rotatory movements.

Some remains of the momentum of the first period undoubtedly influence the second period, but in my opinion this period entails a considerable amount of muscle work. The muscles of the forward leg take a specially active part here. The anterior group works strongly to prevent an increased and excessive plantar flexion at the ankle and the muscles which evert the foot act on the tarsal joints. The *vis inertiæ* of momentum already acquired helps movement forward of the anterior leg, with its ankle dorsally flexed till it reaches a position at right angles to the foot placed on

the ground. Quadriceps femoris must be brought into action to prevent flexion of the knee (which always takes place as soon as we place the foot on the ground) from becoming too great, and also later to extend the knee. I cannot agree with Dalla Rosa that quadriceps femoris does not assist in lifting the body *provided* this begins before the end of the period. Gluteus maximus prevents the rotation of the pelvis in the direction of the movement being continued from the first period, and, together with semi-membranosus, semi-tendinosus and biceps, prevents flexion of the hip. The extensors of the spine prevent the trunk falling forward in the direction of the movement.

The heel of the posterior leg leaves the ground during the second period (if it has not already done so, as sometimes happens in quick walking) by rotating on a transverse axis which passes through the heads of the metatarsals, the ankle being slightly plantar flexed. For my part I consider that this leg, although flexed at the knee, acts as a lever while flexion is maintained or its degree determined by the extensors and flexors working together, and that the special assistance given by the posterior leg during the second period, at least in walking with fairly long steps, begins before the alteration in the height of the hips has taken place.

During the third period the body once again is supported by one leg only, in this case by the anterior leg, while the other, the toes of which have just left the ground, swings forward to the vertical position in profile with the supporting leg. *During this period the centre of gravity must again be raised to its maximum height by muscular action, i.e., by extension of the knee of the supporting leg.* This raising of the centre of gravity, according to the brothers Weber, who have contributed much to our knowledge of the subject of walking, amounts on an average to about 32 mm., and with a body weight of 70 kilos involves 2,240 kgm. of work in 1,000 steps. I consider that it is chiefly quadriceps femoris that produces this extension, that the anterior leg muscles contract strongly to produce dorsal flexion at the ankle, and that the peronei maintain the position of eversion in the tarsal joints, which means, when the sole of the foot is on the ground, that they maintain the abduction of the leg at the tarsal joints. The femur, which in the second period was rotated outward, is again rotated inward by the complete extension of the knee, while the lower leg is flexed. Gluteus maximus is, in my opinion, the most active muscle in extending the hip, but semi-membranosus, semi-tendinosus, and biceps take part to some extent. The pelvis is simultaneously rotated at the hip of the supporting leg partly on its sagittal axis (by all the glutei), so that the other side is raised, partly on its vertical axis (by the

anterior portions of gluteus medius and minimus), so that the side of the swinging leg is carried forward. The extensors of the spine on the side of the raised hip work to prevent the upper part of the body from leaning too far outward during the rotation of the pelvis on the sagittal axis, and also to maintain balance.

The swinging movement of the posterior leg during the periods which, with Dalla Rosa, I have named the third and first has hitherto been considered essentially a pendulum movement in accordance with the explanation of the brothers Weber, and this idea has been almost universally carried too far.

I consider there are three factors producing the forward movement of the swinging leg during the third period—the muscle work of the flexors of the hip, especially ilio-psoas, rectus, femoris, and tensor fasciæ latæ, the weight of the swinging leg acting behind the point of fixation, and, lastly, the rotation of the pelvis round the transverse and vertical axes of the hip of the supporting leg, the muscle work in rotation on the vertical axis being assisted by the acquired momentum. I consider, further, that the proportion of work performed by these different forces varies considerably in different ways of walking, but am inclined to think that in all cases muscular action is the most important.

A pendulum movement of the arms often takes place, especially in quick walking, forward and backward in the opposite direction to the rotation of the pelvis, *i.e.*, the arm swings backward on the side on which the pelvis rotates forward, and *vice versâ*. This is done to assist the rotation of the trunk in the opposite direction to that of the pelvis, and, in my opinion, is the result of muscular activity.

There are few people nowadays who do not consider muscular activity to be the essential force in all kinds of walking. As certainly as walking *downhill* is helped by *gravity*, so certainly is walking *uphill* hindered by *gravity*. If in walking we have some help from the *vis inertiæ* of the mass movements during the period which, with Dalla Rosa, we have called the second, we certainly also use muscular power to raise the centre of gravity, for the muscles of the lower leg fix the ankle in a position of dorsal flexion, while the powerful quadriceps femoris extends the knee. This raising of the centre of gravity varies in different walks, occasionally occurring at the end of the second but generally at the beginning of the third period. One may regard this as a storing up of the force of gravity by means of muscular power. As in a machine for altering the direction of movements, so in the first period, when we allow the centre of gravity which had just been carried obliquely upward and forward to one side to fall obliquely downward and forward

through the sagittal plane to the other side, the force of gravity which had been raised and stored up by means of muscular power is set free as momentum.

When the foot of the swinging leg touches the ground this momentum is converted into heat.

The momentum, when once acquired by muscular force after walking for a short time, naturally helps, especially in quick walking.

In quick walking we increase the number of steps taken in a second and lengthen each step; the latter is done by flexing the moving leg more at the hip. Since this leg can be brought to the ground further forward than before, the posterior leg before leaving the ground is also inclined more than before by means of a stronger dorsal flexion at the ankle. Both knees are then fully extended, the anterior is then raised more from the ground than before, and by stronger plantar flexion at the ankle of the posterior leg the body is powerfully driven forward. If this last movement is done forcibly, the posterior leg may leave the ground before the anterior one has reached it. This means that we have changed from walking to *running*, at least as long as the body is propelled forward in an almost horizontal direction by means of the strong plantar flexion. If, on the other hand, the body is propelled directly upward, which is often helped by flinging the arms upward too, the movement then becomes *jumping*. In both cases the character of the movement has been changed, so that the period during which both feet touch the ground has been exchanged for one in which neither foot touches the ground.

If we want to take one good *run* (maximum length) or one good *jump* (maximum height), we prepare for it by *taking a start*, so producing a rapid momentum and great force. We then land with *both feet on the ground*, and with knees bent, and prevent a jar by bending them still more. This flexion in gymnastic language is termed a combined eccentric flexion. Quadriceps femoris resists this flexion and is thereby lengthened.

From the above we see that the muscle work of walking and running is not confined to the 56 per cent. of our muscle mass which is concerned with the movements of the lower extremities. The extensors of the spine help as well as the lateral flexors of the trunk situated on its dorsal and ventral aspects, and obviously also the muscles which rotate the trunk on its vertical axis. The flexors and extensors of the arm at the shoulder also act, producing the pendulum movement already described. Lastly, to add to all these important facts, we must remember that the whole respiratory apparatus, and especially the respiratory muscles, work more

quickly and strongly during walking than during rest. *In walking we thus use the greater part of our muscular system more completely and harmoniously than in ordinary gymnastic movements, and obtain in the best possible way the physiological effects of exercise on circulation, respiration, and metabolism, to which are due its great hygienic and therapeutic value. Of all "Medical Gymnastic Systems" the most powerful and the most far-reaching is walking.*

CHAPTER IX.

TECHNIQUE OF SWEDISH (MANUAL) MEDICAL GYMNASTICS AND THE EFFECT OF SPECIAL EXERCISES.

By Dr. J. Arvedson.

Introduction.

I agree with Dr. Kleen in considering that by *gymnastics* is meant the exercise of those parts of the body belonging to its motor apparatus, and that *medical gymnastics* consists of positions and movements taken and performed by a patient in the treatment of various deformities and diseases.

By *massage*, on the other hand, is meant a mechanical influence with a therapeutic aim, applied by means of movable pressure produced by certain manipulations (strokings, kneadings, pinching, beating or tapping, etc.) on the soft parts.

Briefly, gymnastics may be described as movements (and positions), massage as manipulations.

Swedish medical gymnasts have in practice always made use of gymnastics proper as well as of other manipulations, such as hacking, clapping, beating, shaking, kneading, etc. They included these, as many still do, among passive movements, but according to the above definitions these manipulations ought undoubtedly to be reckoned as massage, which of course does not prevent their being used by medical gymnasts.

Classification of Movements.

From a gymnastic point of view movements are divided into *Active* and *Passive*.

By *active* movements we mean those in which the patient's muscles are innervated and brought into action.

By *passive* movements we mean those performed in the patient's joints by some outside force, his muscles not being used.

Active movements are divided into—

1. *Free* movements, performed by the patient himself without the assistance of the operator, *e.g.*, Standing 2 (double) Arm-raising-outward and-upward.

2. *Resistance* movements, performed with the help of an active operator.

Resistance movements are divided into—

(*a*) *Concentric.*

(*b*) *Eccentric.*

A third form of active muscle action may here be described, though it is not connected with any definite movement, viz., the so-called *Holdings*. By this is meant that the patient holds himself in a certain position already taken. For this certain definite muscles are brought into action, but do not become either longer or shorter while working, and consequently do not perform any actual mechanical work, though they are innervated and brought into action; *e.g.*, Leg-forward-lying Holding, when the patient for a short time maintains himself in Leg-forward-lying position.

In *concentric* movement both ends of the working muscles are brought nearer to their respective centres and the muscles become shorter. This is the case when a movement, *e.g.*, flexion of the elbow joint, is performed by the patient against the resistance of the operator or some other outside force (flexors work concentrically).

In *eccentric* movements the muscles become longer while working, *i.e.*, their extremities go further from their centres. This takes place when a movement, *e.g.*, extension of the flexed elbow, is performed by the operator or other outside force, while the patient resists the movement (flexors work eccentrically).

N.B.—Even in *free movements* the muscles work concentrically or eccentrically, or both, but the resistance is caused by the weight of the moved part of the body and so cannot be modified.

In *holdings* the length of the muscles remains unchanged, so that no movement is performed, but the muscles are innervated, oxidation processes in them are increased, and they are brought into action.

The value of resistance movements lies in the fact that they can be modified and so perfectly adapted to the strength of the patient.

Concentric movements require a large amount of elastic force, and of the heat given off by combustion in the muscle only about 25 per cent. is converted into useful work; the rest goes to raise the temperature of the muscles and of the body. This is the form of movement most used.

Eccentric movements are less tiring, and of the heat given off about 90 per cent. is transformed into work. These movements are used specially in the treatment of paralyses, because muscles are able to perform eccentric movement long before concentric. They are also used in treatment of diseases which are associated with disturbances of innervation, *e.g.*, in chorea and occupation

neuroses, because they compel the patient's careful attention to the innervation of the working muscles. Often the combined concentric and eccentric forms are used, *e.g.*, in the ordinary High-ride-sitting Alternate Trunk-rotation.

In "holdings" combustion is considerably less rapid than in either of the other kinds of muscle action, and no part of the heat given off is converted into mechanical work. Holdings are specially used in the treatment of spinal curvatures. Their chief value lies in the fact that they educate the patient's sense of the correct innervation of the muscles in a particular position, but they also exercise the muscles, and in certain cases stretch the contracted soft parts—*e.g.*, in Side-lying Holding.

Besides the gymnastic division of movements into active and passive, from a physiological point of view we may divide them into two groups, *Voluntary* and *Involuntary*.

Voluntary movements are those which are performed as the result of conscious and controlled impulses of the will.

Involuntary movements are those brought about by impulses which are not directly under the influence of the will. The most important of these are: *associated movements*, *reflex movements*, and *peristaltic movements* of the intestines, as well as the *cardiac movements*.

By *associated movement* is meant a movement arising involuntarily at the same time as another (usually voluntary) movement. There are several different kinds.

(*a*) Associated action between certain non-striated and striated muscles, *e.g.*, between the muscles of the iris and the external striated muscles of the eye (contraction of the pupil when the optic axes are made to converge).

A similar associated movement exists between the non-striated muscles of the alimentary canal and the external abdominal muscles.

(*b*) Associated movement, or a tendency to it, between the muscles of the two halves of the body.

(*c*) Associated movement between muscles which do not apparently stand in any close connection with one another, *e.g.*, grimacing when performing movements of precision, the tendency to flex the hip joint in heaving movements, or to hold the breath during strong movements even when the working muscles do not arise from the chest.

By a *reflex movement* is understood a movement which arises involuntarily as the result of a stimulus affecting a sensory nerve being transferred to a motor nerve, and thus causing a muscular contraction.

General Effects of Movements.

Effects of Active Movements.

(*a*) The blood supply and nutrition of the working muscles are increased because the nutrient arteries as well as the vessels within the muscles dilate. At the same time metabolism and production of heat are increased. By continued exercise the muscles are developed and become stronger. If the actual length of a certain muscle is to be diminished, it is made to work in as strong shortening as possible, *i.e.*, in the inner part of its range of movement.

(*b*) Because of the increased supply of blood to the working muscles the amount of blood in the other parts of the body is diminished. In this way we can by certain movements influence the distribution of blood in the body, and so, according to need, increase or diminish the quantity of blood in the different parts. By strong leg movements we can thus deplete the head.

(*c*) The mobility of the joints is increased, especially if the movements are taken to the extreme limit.

(*d*) The heart's contraction becomes stronger, partly by reflex action and partly through the influence of the products of metabolism.

(*e*) Circulation in the veins is assisted in various ways :—

(1) Because the contracting muscles, becoming thicker, press upon the veins in their vicinity and press their contents onward towards the heart (valves hinder the return towards the capillaries).

(2) Because the movements cause an alternate lengthening and shortening of the veins passing over the joints moved, a pumping of the blood takes place towards the heart, since the capacity of a blood vessel is alternately increased and diminished with moderate lengthening and shortening.

(3) By the presence of so-called " venous pumps," especially at the larger joints. These are due to the fact that the walls of the veins are partially adherent to the fascia or tendon sheaths, which, partly on account of the actual movement in the joint and partly through the contraction of their attached muscles, are alternately stretched and lifted from the tissues beneath and pressed down upon them. This, of course, causes an alternate increase and diminution of the capacity of the veins and consequent pumping. The best example of a venous pump is to be found at the knee joint, where soleus arises from a tendinous band passing between the tibia and fibula, to which the posterior wall of the posterior tibial vein is adherent.

(*f*) The respiratory organs are also affected by active movements, the increased need of oxygen forcing them to work more strongly, so that the mobility of the ribs is increased and the respiratory muscles are developed and strengthened. By means of improved respiration both the pulmonary and systemic circulations are benefited.

In the systemic circulation the flow of blood to the large veins in the thorax is increased because negative pressure is increased by deeper inspirations. The pulmonary circulation is helped by the alternately increased and diminished expansion of the lungs and the consequent lengthening and shortening of the blood vessels, causing pumping of the blood.

(*g*) Because every active movement requires for its performanec complicated exercise of the brain and nervous system, these organs, and especially those parts which are brought into action, receive increased blood supply and nutrition, and are also exercised and developed.

(*h*) Inereased metabolism causes eventually increased need of nourishment, and, in connection with this, increased work for the digestive organs, and increased work for, and greater activity of, the organs of excretion. All this occurs partly by reflex action, partly by direct stimulation of the various organs by the resulting products of combustion.

Effects of Passive Movements.

(*a*) Mobility of joints is increased by stretching the shrunken joint capsules, contracted muscles, adhesions between tendons and their surroundings, etc.

(*b*) Venous circulation is aided by alternate lengthening and shortening of the veins running over the joints moved, as above mentioned.

(*c*) The stretching of the muscles belonging to the joints moved, which is brought about by passive movements, ought also to exercise a definite influence upon them in the direction of inereased nutrition and metabolism in them.

The Special Effects of Massage Manipulations.

(*a*) Given gently they produce a slight stimulation of the cells of the tissues manipulated, whereby their activity is increased.

(*b*) Given strongly they assist in breaking up inflammatory products.

(*c*) When applied to nerves these are brought into action and

consequently receive an increased supply of blood and improved nutrition. The stimuli produced are conducted directly to the respective muscles, which by this means are brought into action, and to the spinal cord, from which they go out as reflex stimuli to the different parts of the body and there produce various reflexes. They also break up inflammatory products in the nerves and their surroundings.

Estimation of the Special Effects of a Movement.

In order to estimate the special effects of a movement one must take into consideration :—

1. The joint or joints in which the movement takes place, and also the axes of the movement.
2. The muscles which perform the movement, and their mechanical conditions and mode of working.
3. The muscles which must be brought into action in order to fix the origins of the working muscles.
4. Resistance to the movement, its amount and mechanical conditions.
5. The effect of the starting position.

Taking these into consideration, as well as the laws of physiology and gymnastic experience, one is able to estimate the most important special effects of the movement with regard to the circulation and the distribution of blood in the body, respiration and the conditions connected with it, pressure conditions in the abdomen, exercise for the nervous system, stretching of soft parts, —ligaments, muscles, adhesions, etc.,—and finally on the position of the whole body and its particular parts through altering the actual length of certain muscles and their tone.

In the following description of the movements I have, for the sake of clearness, divided them into Leg, Arm, Head, and Trunk movements, according to the different parts of the body. Later follows the description of the special massage manipulations, and finally come the exercises specially used for spinal curvatures.

Gymnastic Apparatus.

The apparatus used in medical gymnastics is particularly simple, and can, if necessary, very well be replaced by ordinary furniture or improvised apparatus.

The most usual are :—

Low plinth.

High plinth. Usually there are two or more of different heights, 55 to 75 cm.

Stools.

Boom.

Peg-post or *wall-bars.*

Two poles, preferably movable, or with a distance between them of 70 to 80 cm.

Straps for fixing the patient.

Cushions to lie upon.

For the treatment of spinal curvatures the following are specially used :—

Head-suspension apparatus. (Similar to Beely's or Sayre's well-known apparatus for suspension of the patient when applying plaster jackets, but somewhat modified.)

Correcting belt.

Forward-drawing straps, i.e., a piece of saddle-girth about 70 cm. long, 8 cm. broad, with a handle at either end. All this apparatus can be obtained from E. G. Ekstrand in Stockholm; address, Jernvägsgatan 16.

Starting Positions.

In order that a movement may always be performed in the same way, and thus have a definite and measurable effect, it is given from a definite starting position, which, as far as the character of the movement allows, must be maintained carefully throughout the exercise.

For active movements the object of the starting position is generally to give the working muscles a firm origin. For passive movements and massage manipulations, on the contrary, the aim is complete relaxation of the joints and muscles or of the tissues manipulated.

Besides this, certain starting positions considerably modify the effect of a movement and produce certain specific effects upon the body, which will be again referred to in the description of the positions.

Starting positions are divided into FUNDAMENTAL and DERIVED positions. The former consist of the simplest positions :—*Standing*, *Knee-standing*, *Sitting*, *Lying*, and *Hanging*. The derived positions arise from the fundamental positions by altering the position of one or more parts of the body. *Stretch-standing* is thus derived from standing position by stretching the arms upward; *Stretch-stride-standing* by also moving the feet apart; *Stretch-stride-turn-standing* by further rotating the trunk towards one side.

In this way an almost endless number of positions may be derived from the fundamental positions. In the following pages, however, only those most used in practice are described.

Fundamental Positions.

Standing Fundamental Position (Fig. 33).—In taking this position—

1. The heels must be together in the same frontal plane (in cases of knock-knee this is not possible).

2. The feet must form a right angle with each other. In Denmark and elsewhere the angle is given as about 70°.

3. The knees must be fully extended, or even somewhat hyperextended.

4. The trunk must be held erect, with shoulders lowered and drawn back.

Fig. 33.

5. The head must be kept erect, with chin slightly drawn in. Eyes to the front.

6. The arms must be held close to the sides, with slightly extended elbow, wrist and finger joints, and the palms against the thighs.

The correct position is most easily taken if one attempts to raise the crown of the head as much as possible while the shoulders at the same time are lowered and drawn back.

The principal working muscles for taking and maintaining this position are :—

(*a*) The posterior neck muscles, because the line of gravity for the head falls in front of the cervical spine.

(*b*) Back muscles, because the line of gravity for the head and trunk combined falls in front of the spine.

(*c*) The posterior shoulder muscles (Trapezius, Lat. Dorsi, Rhomboids), to hold the shoulders down and back.

Besides these, for the balancing of the body in the joints of the spine, hips and ankles, first one and then the other of the muscles passing over these joints must work incessantly.

The line of gravity may by a slight forward movement of the pelvis be put behind the frontal axis of the hip joints, so that stretching of the ilio-femoral ligament prevents the trunk falling back and makes a great deal of muscle action unnecessary ; but in a correct position this does not occur.

The knee joints are, on the other hand, so well fixed by hyperextension and by tension of the ligaments and capsule at the back that their muscles practically need not work.

So far as the ankle joints are concerned, theoretically they ought

also to be sufficiently fixed, because they are ginglymus joints, and because their axes are not parallel but form an angle of 70° to 90° with each other, but on account of the gliding in them the help of the leg muscles is necessary for balancing the body.

Effects and Uses.—1. The chest is expanded (the shoulders being drawn back and the spine extended).

2. The internal organs have ample space, so that they are not hampered in their functions by undue pressure.

3. Deportment is improved.

4. The position is not steady, partly because the base is small (made by the lines drawn along the outer borders of the feet and between the big toes), partly because the centre of gravity lies so high above the base (centre of gravity lies between third and fourth sacral vertebræ).

It is *used* as starting position for a number of free-standing exercises. Its greatest importance, however, lies in the fact that a large number of positions are derived from it, so that a fault in the fundamental position makes all the derived positions faulty.

Fig. 34.

Knee-standing Fundamental Position (Fig. 34).—If this position is taken on a plinth, the feet should lie just beyond the edge, with the dorsum touching the plinth. The knees should be together, and the position of the body otherwise the same as in the preceding position.

If the position is taken on the floor, the ankle joints should preferably be plantar flexed, but may be dorsal flexed.

The working muscles are chiefly the same as in standing fundamental position, but the muscles of the knee joint, especially Quadriceps Femoris, must take rather a greater share in balancing the body.

Effects and Uses.—1. Gives more support than the preceding position because :—

(*a*) The base is larger ;

(*b*) The centre of gravity is nearer the base ;

(*c*) The unsteadiness caused by the gliding of the joints becomes less, since the joints of the foot are excluded.

2. The pelvis is fixed, because the origin and insertion of Rectus Femoris are further apart, so that the muscle is more on the stretch. On this account this position is used, or some position derived from it, as starting position in many trunk exercises, in order to give

the working muscles a firm origin, *e.g.*, Knee-stride-standing Alternate Trunk-rotation.

3. Because the muscles of the feet and leg do not take any share in maintaining the position, the effect of a movement done in this position will be more definite and purer than if done in standing position, because the pure effect of the exercise itself will be less obscured by muscle action necessary for maintenance of the starting position.

Sitting Fundamental Position (Fig. 35).—It is taken on a chair, form, or other similar apparatus. In this position the body rests chiefly on the tuberosities of the ischium, but the back of the thighs should also be supported and the feet should rest upon the floor.

The hip, knee, and ankle joints should all form right angles. The knees should be slightly apart so that the position of the legs is easy. The position of the head, trunk, and arms should be the same as in preceding positions.

Fig. 35.

The working muscles for maintaining the position are principally the neck, back, and posterior shoulder muscles.

Effects and Uses.—1. General steadiness in this position is considerably greater than in the previous positions, because :—

(*a*) The base is larger ;

(*b*) The centre of gravity lies nearer the base;

(*c*) Gliding in hip, knee, and ankle joints has no disturbing influence.

2. The pelvis is also firmer, because it rests on the supporting surface.

3. The leg muscles work little, if at all, to maintain the position, so that movements are purer. For all these reasons the sitting fundamental position and its derived positions are much used in medical gymnastics.

Lying Fundamental Position (Fig. 36).—The body lies stretched out upon a horizontal surface, arms to the sides, muscles relaxed.

There is actually no real muscle work necessary for maintaining this position. It is steady and does not disturb the effects of movements and massage.

Is used.—(*a*) For weak patients.

(*b*) For small children, because they often do not understand how to maintain other starting positions.

(*c*) Frequently for massage.

HANGING FUNDAMENTAL POSITION (Fig. 37).—Taken on a horizontal boom, bar, trapeze, or similar apparatus, usually placed so high as to prevent the patient's feet touching the floor. The hands, usually pronated (= overgrasp, if they are supinated the grasp is undergrasp), grasp the apparatus at a distance from each other not less than shoulders-breadth. The arms straight, and carriage of the body otherwise similar to standing position, except that the head is carried slightly back. The body must not hang slack like a sack of flour, but the muscles of the arms and shoulders, especially at the back, must work to avoid too strong stretching of ligaments and capsules, and to prevent sinking together of the shoulders and a contracted position.

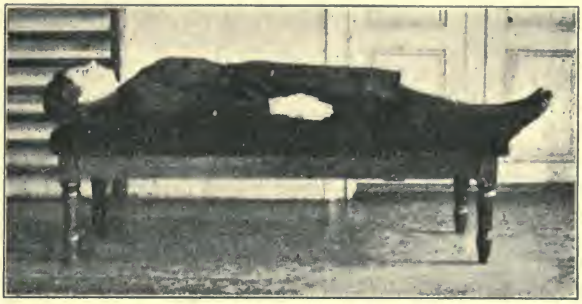

FIG. 36.

FIG. 37.

The working muscles are :—

1. Flexors of fingers, to fix the body to the apparatus.

2. Most of the arm muscles, *i.e.*, muscles which go from forearm to hand, from arm to forearm, and from shoulder girdle to arm.

3. Most of the muscles going from the trunk to the shoulder girdle and arm.

Effects and Uses.—(*a*) Produces a passive stretching of the spine and its ligaments, especially in the lower part, and is therefore used in treating spinal curvatures.

(*b*) Raises the ribs by stretching the shoulder muscles, and is therefore used in the treatment of flat chest.

(*c*) Because the weight of the lower part of the body draws down the ribs, these are fixed, so that respiration, and consequently circulation, are impeded. On this account this position must *not* be used for weak patients, nor for those who suffer from heart or lung complaints.

Derived Positions.

In the derived positions the same muscles of course work as in the respective fundamental positions, and the above effects already ascribed to the former belong also to the latter.

I. Positions Derived from the Standing Fundamental Position.

A. By changing the Position of the Legs.

1. Close-standing.—Arises by rotating the legs inwards in the hip joints, so that the inner borders of the feet touch.

The working muscles are :—

The inward rotators of the hip, viz., Tensor Fasciæ Latæ and the anterior fibres of Gluteus Medius and Minimus.

Effects and Uses.—(*a*) Because the axes of the ankle joints are parallel, the body more easily falls forward than in the fundamental position, so that the calf muscles have increased work in maintaining the position.

(*b*) Mobility of the hip joints is increased, by relaxing the ligaments in front of the joint. On this account it is used for trunk-rotations when it is also desired to exercise the hip joints and their rotators.

(*c*) The base is diminished, so that the position becomes less steady, and thus the line of gravity falls outside the base with the slightest deviation from the position. For this reason first one muscle and then another must work incessantly to bring the line of gravity to the middle of the base. This is done partly by reflex action, partly consciously, and the position thus gives exercise to the reflex apparatus, while at the same time it compels the patient's attention, since for the sake of equilibrium he must continually send considered impulses to one and another muscle or group of muscles.

This is the case with all positions where the base is diminished, and they are called on this account by a common name, " Balance positions," and are used :—

(1) To compel the patient's attention to the movement (*e.g.*, with excitable children or dull patients).

(2) For general disturbances of innervation, *e.g.*, in ataxy, to exercise innervation.

(3) To produce a general gentle muscular action.

2. Toe-standing (Fig. 38).—It arises by plantar flexion of the ankle joint, *i.e.*, lifting the heels as high as possible from the ground.

The body then only rests upon the balls of the toes, and the base is considerably diminished.

The working muscles are :—

The calf muscles. They work first concentrically to take the position, and then statically to maintain it.

Effects and Uses.—The same as in balance positions.

3. KNEE-BEND-STANDING OR CURTSEY-STANDING.—Arises by lowering the trunk till the leg and thigh form a right angle with each other. Dorsal flexion at the ankle joint takes place along with flexion of the hips and knees. The knees are separated on account of the axes of the ankle joints, which form an angle opening backwards. (*N.B.*—The lowering of the trunk is caused by gravity, while the working muscles control the movement by eccentric action, after which they maintain the position by static action.)

FIG. 38.

The working muscles are :—

(*a*) The calf muscles.

(*b*) The extensors of the knee.

(*c*) The extensors of the hip, especially the Glutei.

Effects and Uses.—(*a*) Exercise of the working muscles.

(*b*) Depletes the head and other parts of the body because so many leg muscles are used.

(*c*) Stretches the calf muscles.

Is used very little in medical gymnastics. But it may be of use in after-treatment of fractures of the malleoli to increase the mobility of the ankle joint. It may then be done on one side only.

4. TOE-CURTSEY-STANDING.—Arises by combination of the two previous positions.

The working muscles, effects and uses are the same.

This position is also good exercise for double-sided innervation, and is therefore used in treatment of scoliosis or a tendency to it.

5. WALK-STANDING.—Is taken by moving one foot about two foot-lengths forward in the sagittal plane, maintaining the same angle between the feet.

(In educational gymnastics this position is called Walk *b* standing to distinguish it from Walk *a* standing, which arises by moving the foot forwards and outwards.)

Most of the leg muscles work in taking and maintaining this position.

Effects and Uses.—(*a*) The base is lengthened in the sagittal direction, so that equilibrium is more stable in this plane. It is

therefore used where movement takes place in a forward or backward direction, *e.g.*, in 2 (double) Planc Arm-carrying.

(*b*) Stretching of the soft parts around the hip joint is increased at the back of the anterior leg and on the front of the posterior leg, which helps to fix the pelvis. It is used for many trunk movements to give the working muscles a firm origin, as in forward-bendings; to increase the stretching of soft parts on the back of the hip joint of the anterior leg, as in the treatment of sciatica.

6. Stride-standing.—Is taken by moving one foot two foot-lengths to one side, the angle between the feet remaining the same.

The working muscles are most of the leg muscles.

Effects and Uses.—(*a*) The base is enlarged in a lateral direction, so that steadiness of position is increased in the frontal plane.

(*b*) By stretching the adductors and some of the ligaments of the hip joint the pelvis is fixed. It is used on this account partly in movements which require steadiness in the frontal plane, partly for trunk movements, *e.g.*, active Trunk-rolling, etc.

7. Crook-half-standing.—Is taken by flexing one hip so that the thigh and trunk form a right angle, while the leg hangs loosely down, also at right angles with the thigh, and the foot is plantar flexed.

The working muscles are :—

(*a*) Flexors of the hip of the raised leg (Ilio-psoas), first concentrically, then statically.

(*b*) Abdominal muscles, statically to fix the origin of the above-mentioned muscles on the pelvis.

(*c*) Back muscles, to counteract the tendency of the abdominal muscles to bend the body forward.

(*d*) The extensors of the supporting leg (Glut. Max., Semi-tendinosus, Semi-membranosus, and Biceps), to prevent the body falling forward at the hip joint owing to the weight of the flexed leg.

(*e*) Most of the muscles of the supporting leg.

Effects and Uses.—(*a*) Exercise and development of all the working muscles.

(*b*) Balance exercise, through diminishing the base (see Close-standing Position).

(*c*) Increased peristalsis, owing to associated movement between the abdominal muscles and non-striated muscles of the alimentary canal.

(*d*) Repleting to the pelvis, owing to work of Ilio-psoas (according to Thure Brandt).

8. Step-standing.—Similar to the above position, but the raised foot is placed upon a stool or something of the kind,

The working muscles are the same, but after taking the position no special muscle action is required to maintain it.

Effects and Uses.—The soft parts in the region of the groin on the side of the raised leg are relaxed, so that the position is sometimes used when stretching of these parts must be avoided, *e.g.*, after appendicitis, pelvic troubles, operation scars, etc.

9. INSTEP-SUPPORT-STANDING.—Is taken by bending one knee and allowing the ankle to be supported by some apparatus behind the patient, as a stool. The bent leg is usually carried slightly back.

Effects and Uses.—(*a*) Makes an exercise harder, because the weight of the body is chiefly supported by one leg (double work for these muscles.)

(*b*) Pelvis is fixed owing to stretching of Rectus Femoris of the bent leg and of the ligaments in front of the hip joint.

Major Thure Brandt often used this starting-point for Knee-bendings, to increase their repleting effect to the pelvis. The increased stretching of Rectus Femoris tilts the pelvis forward in the hip joint and produces a strong arch position, which, according to Brandt, has the above effect (see Arch Position).

FIG. 39.

10. HEEL-SUPPORT-STANDING. — Is taken by placing one foot on some apparatus in front, so that the heel rests on it. The knee is extended.

Effects and Uses.—(*a*) Makes exercise more difficult, because the body is supported only on one leg.

(*b*) Produces increased stretching of the soft parts at the back of the raised leg. Is used specially in Forward-bending, in order to produce a strong stretching of the sciatic nerve.

11. FALL-OUT-STANDING (Fig. 39).—In medical gymnastics the position chiefly used is that called in educational gymnastics Fall-out *b* standing. This is taken by moving one foot three foot-lengths forwards or backwards in the sagittal plane, maintaining the same angle between the feet. At the same time the body falls forward and the front knee is bent until it comes to be over the point of the toes. The trunk and the fully-extended posterior leg must be in a straight line.

In order to take up and maintain this position a large number of muscles must be brought into action, especially the back muscles, more particularly those in the lumbar region on the opposite side to the posterior leg. The position is therefore used in treatment of scoliosis, to correct a curve in the lumbar region with the convexity on the opposite side to the posterior leg.

If the arm which corresponds to the anterior leg is stretched up as much as possible and held in a line with the trunk and posterior leg (the other arm extended slightly backward), the muscles in the upper region of the back are in this way made to work strongly on the opposite side to the upward-stretched arm. This modification of the position is therefore used in treating double curves: Right (arm)-stretch (Left leg backward) Right Fall-out-standing position for a double curve, with the upper convexity to the left and the lower to the right.

B. Positions derived from Standing by changing the Position of the Arms.

In most of the positions belonging to this group the posterior shoulder muscles contract more strongly than in the Fundamental position, so that they also produce a stronger expansion of the thorax.

Fig. 40.

1. Hips-firm or Wing-standing (Fig. 40). —In taking this position both hands are carried (along the sides) up to the crests of the ilium, against which they are pressed with the palmar surfaces turned down, thumbs backward and the fingers forward. The elbows ought to be carried so far back that the arms lie as nearly as possible in a line with the clavicle, the shoulders being lowered and somewhat drawn back.

The working muscles for taking and maintaining this position are chiefly :—

(*a*) Deltoid.

(*b*) Biceps and Brachialis Anticus.

(*c*) Adductors of the shoulder joint (Pectorals, Lat. Dorsi, etc.). They press the hands on the crests of the ilium.

(*d*) Triceps; help to press the hands against the iliac crests, but produce also a passive stretching of the spine.

Effects and Uses.—(*a*) The arms are fixed and their weight transferred to the crests of the ilium, so that trunk movements are facilitated.

(*b*) The chest is expanded, partly by the increased work for the shoulder muscles spoken of above, partly because the Pectorals and Lat. Dorsi draw up the ribs. Their attachments on the upper arm are more firmly fixed than on the ribs.

(*c*) The spine, especially the lowest part, is passively stretched.

(*d*) The trunk is made firm, because the arms act as buttresses.

It is used on this account in many trunk and leg movements, to help in maintaining the position of the body during the movement.

2. Talk-standing.—Arises by rotation outward of the arms and hands.

The working muscles are :—

(*a*) Outward rotators of the arm (shoulder joint), Supra- and Infra-spinatus and Teres Minor.

(*b*) Outward rotators of the forearm (radio-ulnar joint), Brachio-Radialis and Supinator Brevis.

Effects and Uses.—The outward rotation of the arms causes increased stretching of the pectorals, so that the ribs are raised and the chest expanded.

It is used in order to produce merely a slight expansion of the chest, *e.g.*, at the beginning of the after-treatment of a severe lung illness.

3. Bend-standing.—Arises from talk-standing, by flexing the elbow joints as far as possible. The finger and wrist joints are slightly flexed, the elbows close to the sides, the shoulders lowered and drawn back.

The working muscles are :—

(*a*) The same as in the preceding position, the outward rotators of the arm and the supinators.

(*b*) The flexors of the elbow (Biceps, Brachialis Anticus, Brachio-Radialis).

Effects and Uses.—This position in itself has no special effect, but is of great importance, because it is taken in all arm stretchings and must therefore be practised before these.

4. Yard-standing (Yard *c*) (Fig. 41).—Arises by abduction of the arms to the horizontal plane. The shoulders must not be raised, but kept lowered and drawn back. The arms are carried so far back that they are in a line with the shoulders. Hand and finger joints extended, palms turned down, fingers closed.

The working muscles are :—

(*a*) Deltoid ; works on the humero-scapular joint.

(*b*) Trapezius and Serratus Magnus ; work upon the acromio-clavicular and sterno-clavicular joints.

(*N.B.*—The movement does not take place only in the humero-scapular joint, but also in the acromio-clavicular and sterno-

clavicular joints. The movement in the latter, however, is not great if the position is correctly taken.)

Effects and Uses.—(*a*) The thorax is expanded more than in the preceding positions, because the origin and insertion of the Pectorals and Lat. Dorsi are further apart.

(*b*) Because the posterior shoulder muscles must work strongly and in full contraction (shortening), they are strengthened and their tone is improved (*i.e.*, their real length is diminished, so that they become more tightly stretched between their origin and insertion). By this means the position of the shoulders is improved.

Fig. 41.

The position is used for the above reasons in the treatment of flat chest and "winged" shoulders.

5. Forward-bend-standing (Yard *a*).—Arises from yard-standing by flexion in the elbow joint. The elbows are held well back.

The working muscles are :—

(*a*) Same as in the preceding position.

(*b*) Flexors of elbow.

(*c*) Posterior fibres of Deltoid, to carry the elbows back.

Effects and Uses.—Chiefly similar to the preceding position, but less tiring because the centre of gravity of the arm lies nearer to the shoulder joint.

6. Heave-standing (Yard *e*) (Fig. 42).—Arises from yard-standing by :—

(*a*) Outward rotation of the arms and supination of hands.

(*b*) Flexion of elbow joint to a right angle between the arm and forearm.

The working muscles are :—

(*a*) Same as in yard-standing.

(*b*) Outward rotators of the arm Supra- and Infra-spinatus and Teres Minor).

(*c*) Supinators of hand and forearm (Supinator Brevis, Brachio-Radialis).

(*d*) Flexors of the elbow and their antagonists (Biceps, Brachialis Anticus, Triceps).

Effects and Uses.—Same as in the two preceding positions, but the expansion of the chest is somewhat stronger (stretching of the Pectorals and Lat. Dorsi being increased by outward rotation of the arms).

It is used in many chest expansions, to facilitate the expansion. Heave position of the arms is used also in many trunk movements to give the operator a long lever and thus make the exercise harder for the patient, *e.g.*, in Heave-stoop-stride-sitting Alternate Trunk-rotation.

FIG. 42.

7. REACH-STANDING.—Arises from the fundamental position by bringing the arms forward to the horizontal plane. The shoulders are lowered and drawn back; they must not be raised or pushed forward. The elbow, hand and finger joints are extended, the fingers closed; hands the width of the shoulders apart, palms facing each other.

The working muscles are :—

(*a*) Coraco-brachialis and the anterior fibres of Deltoid; act on the humero-scapular joint.

(*b*) Trapezius and Serratus Magnus; act on the sterno- and acromio-clavicular joints.

This position compresses the thorax slightly, because the weight of the arms tends to rotate the scapulæ backwards and inwards; this is prevented by Serratus Magnus, thus causing a dragging backward and downward of the costal origin of Serratus, so that the ribs are lowered.

That the same effect is not present in Yard, Forward-bend, and Heave-standing positions depends upon the fact that the lowering of the ribs is counteracted by stretching of the Pectorals.

8. REACH-GRASP-STANDING ("AGAINST") (Fig. 43).—Like the above position, but the hands rest against or catch hold of some apparatus, boom, rib, etc.

Effects and Uses.—It fixes the body, especially the shoulders and

trunk, and is therefore used in Head-rolling, Back-raising, Neck-raising, and many other exercises where the position is otherwise hard to maintain ; also in Heel-raising Knee-bending, so that the muscles of the arms may help to make the movement easier (for weak patients and beginners) ; and, lastly, in the early practice of balance movements and positions, *e.g.*, Crook-half-standing position and others.

Fig. 43.

9. Neck-firm, or Neck-rest-standing (Fig. 44).—Taken by carrying the hands up to the back of the neck, against which the fingers rest, with the tips touching or slightly interlocking. The elbows well back, hands and finger joints well stretched, head high.

The working muscles are :—

(*a*) Same as in Heave-standing, but the flexors of the elbow as well as Trapezius and Serratus Magnus are more contracted.

(*b*) The posterior shoulder muscles must also work strongly to counteract the tendency of the elbows to be drawn forward by the increased stretching of the Pectorals.

(*c*) Similarly the neck muscles, and those muscles which go from the upper part of the back to the neck and occiput, must increase their action in order to prevent forward bending of the head by the tense inward rotators of the arm.

Fig. 44.

Effects and Uses.—(*a*) The thorax is more strongly expanded than in the preceding positions.

(*b*) The centre of gravity for the body is raised, so that trunk movements are made more difficult.

(*c*) The upper back muscles are strengthened and developed, so that the position of the head is improved.

(*d*) Used in trunk movements, the position gives the operator a long lever for resisting, and in this way makes the exercise more difficult.

(*e*) The sides of the thorax are more easily got at for treatment by hacking, clapping, etc.

(*f*) If the position is taken with one arm only it produces a raising of the shoulder on the same side, for which reason it is used in treatment of scoliosis.

10. Head-rest, or Forehead-rest (firm).—Taken by carrying the hands up and resting them on the crown of the head or the forehead.

The working muscles and the effects and uses are practically the same as in the preceding position, but, because the elbows are not so strongly carried back and the upper arms are rotated less out, the muscle action, both for taking the position and keeping it, is considerably less. It is therefore used for beginners and weak patients instead of neck-rest position.

Fig. 45.

11. Stretch-standing (Fig. 45). — Arises when the arms from bend, reach, or yard position are carried up to vertical position. Elbow, wrist, and finger joints extended. Distance between the hands equal to or rather greater than shoulders-width, palms facing each other, fingers closed. (*N.B.*—Position of the trunk must not be altered.)

Beginners and people with stiff shoulder joints have a tendency to help the complete stretching to vertical position by bending backward in the joints of the vertebræ.

The chief working muscles are :—

Deltoid, Trapezius, and Serratus Magnus, but all the shoulder muscles are of course more or less brought into action.

Effects and Uses.—(*a*) The thorax is expanded more than in all the previous positions ; the four lowest ribs especially are raised by stretching the digitations of Latissimus Dorsi, which are attached to them.

(*b*) The centre of gravity of the body is raised, making trunk movements more difficult.

(*c*) The operator has a long lever, and at the same time the shoulder muscles are forced into strong action to maintain the position of the arms, so that the movement is made more difficult, *e.g.*, in Stretch-stride-standing Alternate-side-bending.

12. Half-stretch-standing.—Is taken by stretching only one arm. If the extension is made as complete as possible, the longi-

tudinal muscles of the upper part of the back on the opposite side take part also in the movement.

Fig. 46.

Used partly to give the operator a long leverage, partly in the treatment of scoliosis to raise a low shoulder and to exercise and strengthen the muscles on the convex side. The arm on the opposite side to the convexity of the curve is upward stretched.

13. Crutch-standing (Fig. 46).—Taken by laying one arm over a boom at the level of the axilla, when the arm is pressed in towards the side and fixes the body.

It is used to fix the body, especially the shoulder, in Head Side-bending.

14. Grasp Positions (Yard-, Heave-, Reach-, and Stretch-grasp-standing).—Arise from the respective positions by grasping some suitable apparatus, such as the boom, wall-bars, poles, etc.

Effects and Uses.—The shoulders and upper part of body are fixed, so that :—

(*a*) Certain movements are made easier, because the working muscles are given a firm origin, *e.g.*, in Stretch-grasp-standing Knee-updrawing and -downpressing, Heave-grasp-close-standing Alternate Hip-rotation.

(*b*) Maintenance of the position is made possible in certain passive movements, *e.g.*, Stretch-grasp-standing Forward-drawing, Heave-grasp-standing Chest-expansion.

C. Positions derived from Standing by altering the Position of the Trunk.

1. Stoop-standing (Fig. 47).—Arises by letting the trunk fall forward, chiefly at the hip joints. In this the body must be carried slightly backward (plantar flexion of the ankle joints) so that the line of gravity may fall within the base. The falling may be more or less deep, according to the mobility of the hip joints, but should not exceed a right angle between trunk and thigh. The position of the trunk and head, as much as possible, as in the Fundamental position ; knees straight.

If the forward-bending goes beyond a certain limit, it produces in most people a straightening out, or even a slight forward-bending, of the lumbar spine, because the stretching of Semi-tendinosus,

Semi-membranosus, and Biceps Femoris prevents farther flexion of the hip joint.

The working muscles are :—

(*a*) Flexors of the hip joint (concentrically), but only very slightly and at the beginning of the forward bending, in order to bring the line of gravity in front of the frontal axis of the hip joint.

(*b*) Extensors of the hip, Glutei, Semitendinosus, Semi-membranosus and Biceps Femoris (first eccentrically and then statically).

(*c*) The back muscles (chiefly statically), but the innervation must increase according to the depth of the bending.

Fig. 47.

Effects and Uses.—The position has a depleting effect on the organs of the abdomen and pelvis, on account of the increased blood flow to the working muscles of the back, and the Glutei ; probably also on account of the compression of the abdomen and consequent increased pressure. When Thure Brandt aimed at increasing the depleting effect he made the patient press the lumbar region backward, and keep this up carefully all through the movement.

Fig. 48.

2. Stoop-leg-lean-standing. — Similar to the preceding, except that the front of the thigh is supported against a boom, so that the carrying of the body backward for the sake of balance is unnecessary. The heels should be supported by a bar, or something of the kind, if friction is not sufficient to prevent their gliding back.

Working muscles, effects and uses principally as in the preceding position, but the body is also fixed and the legs particularly firmly. It is used on this account in those movements where the Glutei and back muscles act strongly and where the resistance to the movement presses the body forwards, *e.g.*, in strong Back-raisings and 2 Plane Arm-carryings.

3. Lax-stoop-standing. — Taken by forward and downward falling of the body in the hip joints and joints of the lumbar spine as far as possible. It relaxes the

anterior abdominal wall, and was used formerly (seldom now) in treating the abdominal organs by massage.

4. Backward-bend or Arch-standing (Fig. 48).—Taken by bending backward in the joints of the spine, as much as possible in the dorsal region.

The position of the head on the trunk remains unaltered; knees straight.

The working muscles are:—

(*a*) Back muscles, especially those lying in the middle part of the back.

(*b*) Muscles in front of the neck and trunk, statically because the line of gravity for the head and trunk falls behind the spine.

Effects and Uses.—(*a*) Expansion of thorax. (*b*) Repleting to abdominal and pelvic organs (according to Brandt), possibly because the abdomen is enlarged and pressure is diminished.

Fig. 49.

5. Fall-standing.—The body falls backward at the ankle joints until the line of gravity falls somewhere behind the heels, the position of the body being otherwise unaltered. For this the neck or shoulders must have firm support. It involves static work for all muscles at the back of the body. It is used only for "Fall-standing-raising" (see Back Exercises) and sometimes in 2 Plane Arm-carrying (see Arm Exercises).

6. Side-bend, or Side-arch-standing (Fig. 49).—Arises if the trunk is bent directly to the side.

In this also the flexion must take place as high up as possible. Rotation carefully avoided.

The working muscles are:—

(*a*) Those muscles on the side *towards* which the flexion takes place (concentrically). By side muscles we mean all the longitudinal muscles which lie on the same side of the middle line both at the front and back of the trunk.

(*b*) The muscles of the opposite side (first eccentrically, then statically) as soon as the line of gravity falls on one side of the spinal column.

The position expands one side of the thorax, compresses the other, and is used in treatment of lung diseases, partly to stretch pleuritic adhesions, partly to expand the lung, and partly also to increase the mobility in the joints of the thorax.

7. Turn-standing.—Arises from the Fundamental position by rotating the trunk to one side as far as possible. Position of the head and shoulders in relation to the trunk must not be changed, but the pelvis takes part in the rotation.

The working muscles are (*if rotation is made to the left*, when the anterior lower border of the right side of the thorax approaches the left anterior superior iliac spine) :—

(*a*) Those muscles in front of the trunk which go in a direction from below on the left obliquely upward and to the right (left Internal Oblique, right External Oblique).

(*b*) Those back muscles which go from below on the right obliquely upward and to the left.

(For the sake of brevity we shall call all these muscles the "*left rotators of the trunk.*")

(*c*) For rotation of the pelvis the following muscles work: Inward rotators of the left hip (anterior part of Glut. Med. and Min.), and the outward rotators of the right hip (Gemelli, Obturators, Quad. Fem., etc.). This can easily be understood if one remembers that, on turning the body to the left, the left leg becomes rotated in and the right rotated out in regard to the pelvis and trunk. We call these muscles "*the left rotators of the pelvis.*"

In rotating to the right the corresponding muscles naturally work on the other side of the body.

Effects and Uses.—(*a*) Mobility of the ribs and joints of the spine is increased.

(*b*) Those muscles which rotate to the opposite side are passively stretched, so that they are put into a condition to exercise their full strength in afterwards turning forward. (According to physiology the muscular force is greatest when it begins to contract after a passive over-stretching.) It is used, therefore, to exercise the rotators of the trunk and pelvis.

D. By Combination

of the positions already described a number of new positions may arise, *e.g.*, Wing-close-standing, Yard-stoop-leg-lean-standing, Stretch-stride-arch-standing, etc. Their effects and uses correspond with what has been said of the simple positions.

II. Positions derived from Knee-standing.

In the same way as from standing a number of positions can be derived from the Knee-standing Fundamental position by altering the position of the arms, legs, or trunk.

In the practice of medical gymnastics, however, only the following positions are in use :—

Wing
Neck-rest } *-Knee-stride-standing.*
Stretch

Wing
Neck-rest } *-Knee-stride-arch-standing.*
Stretch

III. Positions derived from Sitting.

A. By altering the Position of the Arms.

Wing
Yard
Heave
Reach-grasp } *-Sitting.*
Neck-rest
Stretch

They arise in the same way as the corresponding derived positions from standing, and have the same effects and uses.

B. By altering the Position of the Legs.

1. Long-sitting.—The patient sits with legs fully extended and supported for the whole of their length ; the trunk and thighs at a right angle. To maintain this position the abdominal muscles and flexors of the hip joint must work, generally also the extensors of the knee.

Effects and Uses.—(*a*) Stretches muscles at the back of the thigh, if they are too short.

(*b*) The pelvic tilt is diminished by stretching the above muscles. This causes again a straightening-out of the lumbar spine and stretching of ligaments and muscles at the back. Therefore used in treatment of lordosis.

(*c*) The abdomen becomes compressed, so that pressure there is increased, and as the abdominal muscles, as already explained, must also work to maintain the position, respiration is impeded. Therefore this position must be avoided for patients with heart or lung complaints.

2. Half-sitting.—Is taken by placing one leg over the boom, so that the thigh is supported just behind the knee joint. The leg hangs straight down by its own weight. The height of the boom is such that the thigh is horizontal. It can also be taken over a high plinth, table, or something similar, when the patient, standing

at the side of the apparatus, places one leg on it in such a way that the leg hangs over the side.

It is used really only for one movement, viz., Knee-bending and -stretching.

The special use of the position consists in the fact that the movement is complicated and made more difficult partly because the muscles of the supporting leg must work to maintain the position, partly because the origin and insertion of Rectus Femoris of the leg which performs the movement approach one another, so that the strength of the muscle is diminished and the stretching made more difficult.

3. STRIDE-SITTING.—Arises from the Fundamental position by placing the feet two foot-lengths away from each other. Right angle between thigh and leg.

Effects and Uses.—Base is enlarged, so that the position is very steady, or can be made so (by work of the leg muscles). It is much used both for trunk and arm exercises.

4. RIDE-SITTING.—Is taken by the patient sitting astride a plinth, chair, form, or other suitable apparatus. The feet are often fixed by some support.

This position fixes the legs and pelvis most firmly of all, and this effect can be increased by fixing a broad strap over the legs.

When the position is taken on a high plinth it is called *High-ride-sitting* (Fig. 50).

FIG. 50.

It is used partly for strong trunk exercises to give the working muscles a firm origin on the pelvis, partly in order to limit a movement as far as possible to the trunk muscles, *e.g.*, Trunk -rotations, Plane-twisting, Arch-twisting, etc.

C. By altering the Position of the Trunk.

1. *Arch*
2. *Stoop*
3. *Turn*
4. *Lax-stoop*

} *-Sitting.*

They have, of course, the same effect and use as the corresponding positions derived from standing.

5. Fall-sitting.—Arises by backward falling of the trunk at the hip joint. For this the feet or knees must be fixed by apparatus or living support. The degree of falling can be modified according to the patient's strength.

The working muscles are :—

(*a*) Flexors of ankle (statically to fix feet).

(*b*) Extensors of knee (statically).

(*c*) Flexors of hip (first eccentrically, then statically).

(*d*) Abdominal muscles (statically).

(*e*) Muscles at front of neck (statically).

In a word, all the muscles in front of the body.

Effects and Uses.—(*a*) Repleting to pelvic organs (according to Brandt, because Ilio-psoas works).

(*b*) Because the abdominal muscles are exercised and developed it counteracts lordosis and aids peristalsis (by associated action of the abdominal muscles with those of the intestines).

(*c*) Impedes respiration. Should be avoided, therefore, for patients who are weak or suffer from heart or lung diseases.

Fig. 51.

6. Spring-sitting (Fig. 51).—This position resembles Fall-out *b* standing, but is unlike this in that the anterior thigh rests on some suitable apparatus, stool, high plinth or something similar. The arms (both or one) in Wing, Neck-firm, or Stretch position.

Effects and Uses.—The same as Fall-out-standing position. Left-spring-sitting position (left foot forward) corrects, consequently, a lumbar scoliosis with convexity to the left.

Right-stretch Right-spring-sitting position corrects an S (double) curve with upper convexity to left, the lower to the right.

D. By Combination

we get, among others :—

Wing-high-ride-sitting.
Stretch-stoop-stride-sitting, etc.

Their effects may be understood from those of the simple positions.

IV. Positions derived from Lying.

A. By altering the Position of the Arms.

Wing
Neck-rest } -*Lying.*
Stretch

B. By altering the Position of the Legs.

1. STRIDE-LYING.—Used in massage treatment of the inner side of the thigh, perineum, etc.

2. CROOK-LYING.—Arises from the Fundamental position by flexion at the hip and knee joints, so that the feet are drawn up against the buttocks and the whole sole rests on the supporting surface.

Effects and Uses.—The anterior abdominal wall is relaxed, so that the abdominal organs are more easily accessible by massage.

3. SIT-LYING.—Arises if the patient is placed so that the legs hang freely down beyond the edge of the supporting surface.

Effects and Uses.—(*a*) The body is firmly fixed, *e.g.*, for a strong Arm-downdrawing.

(*b*) Because the origin and insertion of Rectus Femoris are separated from one another Knee-extension is easier.

(*c*) Because of the increased stretching of Rectus Femoris the pelvic tilt is increased, so that a slight lordosis arises.

C. By altering the Position of the Trunk.

1. HALF-LYING.—Patient rests on a bed, low plinth, or other apparatus, so arranged that the trunk takes a position half-way between sitting and lying positions. The legs may either be straight or rest on the support or some suitable extension of the same, or they may be flexed at the knee joints with the feet resting on the ground (or a stool of suitable height).

Effects and Uses.—(*a*) The position is comfortable and restful, and is therefore used for weak and delicate patients.

(*b*) Because it does not require the use of any muscles, but is firm in itself, it allows the effect of a movement to be as pure as possible, and is on this account much used in medical gymnastics.

2. CROOK-HALF-LYING.—Arises by combination of Crook-lying and Half-lying. It is more comfortable than Crook-lying position and relaxes the abdominal wall better, so that it is nearly always used when the abdominal viscera are to be treated by massage of one kind or another.

3. FORWARD-LYING.—The patient lies prone on a plinth or other

support. Used for massage of back. (*N.B.*—Impedes respiration, and must therefore not be used for patients with heart disease.)

4. Leg-forward-lying (Fig. 52).—Patient lies prone on a (high) plinth, with only the legs resting on it, while the trunk lies beyond the edge of the plinth in a line with the legs. The feet and legs are fixed by a strap, or a so-called "over-sitter."

It is best taken by letting the patient kneel on the apparatus as far back as the length of the thighs. He puts his hands on the shoulders of the operator, who stands in front and holds him in the axilla. The over-sitter now takes his place on the patient's legs. (*N.B.*—Patient's feet rotated out.) The patient then falls forwards in the hip and knee joints and is gently carried down to the horizontal position. The position of the head and trunk is now corrected so that it resembles Standing Fundamental position.

Fig. 52.

Recovery from the position takes place either by rotation of the trunk when the patient gets up to Sitting position, or the patient goes back to Knee-standing position, care being taken to flex the hips first, while the operator, by support in the axilla or with the hands, helps the patient up.

The working muscles for maintaining the position are :—

(*a*) Extensors of hip.

(*b*) Back muscles.

(*c*) Neck muscles. That is, all the muscles at the back of the body working statically.

Effects and Uses.—(*a*) The feeling of equal innervation to both sides of the back is exercised, so that the position is of great value and use in treatment of scoliosis or a tendency to it.

(*b*) The back muscles are exercised, and strengthened, so that a good position of the body is made easier.

5. Arch-leg-forward-lying Position (Fig. 53).—Arises from the preceding position by bending backwards in the joints of the spine. *The working muscles* are the same, but they are contracted as strongly as possible.

Fig. 53.

Effects and Uses.—(*a*) Same as in the preceding.

(*b*) There is especially produced a stretching of the soft parts on the front of the body and spine, while the back muscles are shortened, so that the position is effectual in kyphosis and flat chest. (*N.B.*—It easily produces lordosis, which must be counteracted by suitable positions.)

6. Leg-side-lying and Arch-leg-side-lying (Fig. 54).—The patient is placed on one side on a high plinth, so that the leg of the under side rests upon the plinth in its whole length from the great trochanter to the foot. The other leg is placed immediately behind the first. An over-sitter sits on patient's legs and feet and fixes them. The trunk extends beyond the edge of the plinth and is supported by the operator with its frontal plane vertical; the lower arm in Neck-firm position, the other along the side of the body. The head should not be bent towards the upper side, but must be kept in such a position that the cervical spine does not diverge from the direction of the spinal column, but forms a direct continuation of it. If the patient from this position makes a side-bending of the trunk upwards and

Fig. 54.

holds there, ARCH-LEG-SIDE-LYING POSITION arises. To maintain the position all the longitudinal muscles on the upper side work statically.

Effects and Uses.—(*a*) Ligaments of the spine on the lower side are stretched.

(*b*) Muscles of the upper side are exercised, developed, and shortened. On this account the position is used in simple scoliosis.

D. By Combination.

Here also a number of different positions arise, *e.g.*, Stretch-half-lying, Neck-firm-arch-leg-forward-lying, etc.

V. Derived Positions from Hanging.

1. ARCH-HANGING (Fig. 55).—Taken on a horizontal boom at the height of the patient's head or chest (easier in the former). Hands (pronated) are placed on the apparatus as in Hanging position, after which first one leg and then the other is carried back and supported by the tips of the toes on the ground. At the same time the body is lowered carefully, so that it finally comes to hang with fully extended arms and equally extended knees and forms an arch convex forward. Head carried slightly back with chin in.

FIG. 55.

Effects and Uses.—Stretches the ligaments and muscles in front of the spine and body, and is therefore used in treating kyphosis.

2. CROOK-HANGING. — Taken on a wall-bar or double boom, so arranged that the lower boom supports the patient's sacrum.

It arises from the Fundamental position by bending and drawing up the legs so that the thighs form a right angle with the trunk and with the legs. Feet plantar-flexed.

The special muscles for taking and maintaining the position are :—

(*a*) Flexors of hip
(*b*) Abdominal muscles } first eoneentrieally, then statieally.

(*c*) Arm and shoulder museles (statieally).

Effects and Uses.—(*a*) Strengthens and shortens the abdominal muscles, and is used, therefore, in treating lordosis.

(*b*) Like the positions above deseribed, where the flexors of the hip and the abdominal museles work, *e.g.*, Crook-half-standing, it aids peristalsis, repletes the pelvis, and impedes respiration.

3. Heave-hanging.—Arises from the Fundamental position by flexion at the elbows and adduetion of the upper arms in the joints of the shoulder girdle, so that the body is heaved up to a right angle both between the arm and forearm and between the arm and trunk. Elbows in the frontal plane, and the position of the body otherwise as in Fundamental position.

The working muscles, besides those used in hanging, are :—

(*a*) Flexors of elbow.

(*b*) Adductors of the humero-seapular joint (Pect. Major, Lat. Dorsi, Teres Major).

(*c*) Inward rotators of the scapula at the acromio-clavicular joints (Rhomboids).

(*d*) Adductors of the sterno-clavicular joint (Pect. Minor and lower part of Trapezius).

Effects and Uses.—Chiefly similar to the Fundamental position, but on account of the stronger action of the muscles mentioned it is also used as a strong arm movement in gymnastic training.

Summary of the Effects of the Starting Positions.

By choosing suitable starting positions we can make a movement easier or more difficult :—

(*a*) By giving the working muscles a more or less firm origin. Trunk rotation is easier in Ride-sitting position than in Knee-stride-standing. (*N.B.*—The firmer the fixation of the muscle origin the purer and more localised becomes the effect of the exercise.)

(*b*) By altering the position of the centre of gravity in the part of the body to be moved—*e.g.*, raising from Sit.-ly. position is more difficult in Neck-firm or Stretch position of arms.

(*c*) By separating the origin and insertion of the working muscles and thus increasing or diminishing their strength—*e.g.*, Knee-extension is much easier in Sit.-ly. than in Half-sit. position.

(*d*) By giving the operator a shorter or longer lever. Alternate Trunk-rotation is much more difficult if the arms are in Neck-firm

than in Wing position, because the resistance, being the same in both cases, is put in the former upon the elbows, *i.e.*, far away from the axis of rotation, in the latter upon the shoulder joint, *i.e.*, nearer the axis.

We can, moreover, by certain starting positions *fix* the body or the different parts in such a way that passive stretchings can be thoroughly and effectively given, *e.g.*, Grasp positions.

Also we can produce *lessened contraction or relaxation* in those parts which are to be massaged or treated by passive movements, *e.g.*, Cr.-half-lying position for abdominal massage, etc.

Finally, many starting positions have a quite special effect upon the body, and are used on this account either to modify the effects of an exercise, or are given as exercises, *e.g.* :—

(*a*) *Stoop positions* deplete, *Arch positions* replete the abdominal and pelvic organs (Brandt).

(*b*) *Leg-forward-lying* and *Arch-leg-forward-lying* exercise equal innervation of the back muscles and the sense of the correct holding of the trunk, and at the same time the back muscles are strengthened, so that these positions are used in treatment of spinal curvatures.

(*c*) Hanging position exercises a stretching effect on shortened ligaments and muscles.

(*d*) Most positions derived by altering the arms cause an expansion of the thorax.

Gymnastic Movements.

General Rules for giving Movements.

1. The gymnast must take a suitable position, so that he can easily, and with the minimum expenditure of energy, give the exercise evenly, firmly and continuously. (Experience soon teaches him this.)

2. The gymnast, and especially the patient, must both breathe freely throughout the movement.

3. Respiratory exercises and most trunk exercises must be given in time with breathing. Movements of the extremities may generally be given rather more quickly.

4. All grasps must be with a flexible hand, firm, but without pinching.

5. During the exercise there must be a slight stretching lengthwise by the gymnast of the part moved.

6. As a rule the movements must be taken to the limit.

7. In resistance movements the resistance must be given from the very beginning to the end of the movement.

8. Resistance must be carefully regulated according to the strength of the patient. Shaking or unevenness of the movement shows that the resistance is too strong or that the exercise itself is too hard for the patient.

9. At the limit of the movement a little over-stretching is given, partly to increase the range of movement, partly to stretch passively the muscles which are going to work and so increase their strength.

Leg Movements.

Leg movements, as a rule, deplete the head and upper part of the body. They also have the above-mentioned general effects of active movements. It should be noted that most leg movements do not in any way impede respiration, and on this account they may be given to weak patients and to certain cases of heart disease earlier than arm exercises. An exception to this is made by all those exercises in which the flexors of the hip work, because the abdominal muscles must also be brought into action to fix their origin.

Movements in the Ankle Joint.

Half-lying
Reach-grasp-high-standing — *Foot-bending and -stretching.*
Free-standing

Half-lying Foot-bending and -stretching (Fig. 56).—The gymnast sits in broad stride-sitting position, facing the outer side of the patient's foot. This is placed over the gymnast's knee so that the heel in strong plantar flexion lies on the inner side of the knee. The gymnast grasps the anterior part of the metatarsal bones, with one hand placed on the dorsal and one on the plantar surface. Against the resistance of the gymnast the foot is bent and stretched alternately five to eight times each way, when the above mentioned over-stretching is made at the limit of each movement. Usually the movement is finished by a passive dorsal flexion with gentle shaking.

As a rule, and when no other special way is prescribed, the exercise is given in the above manner, *i.e.*, so that the muscles work concentrically, but it can of course also be given concentrically and eccentrically, or with only eccentric work, or as a purely passive movement.

If the muscles are to work both concentrically and eccentrically the patient bends the foot upwards (dorsally flexes) while the gymnast resists, and then the gymnast extends (plantar flexes) the foot while the patient resists; the dorsal flexors work concen-

trically and eccentrically. Afterwards the patient extends against the resistance of the operator, who then flexes the foot against the resistance of the patient; the extensors work concentrically and eccentrically.

If the movement is to be double—2 *Foot-bending-stretching*—the gymnast sits in front of the patient, whose feet rest on a stool or on a cushion on the gymnast's knees.

It can also be given in the first way by two gymnasts.

HIGH-REACH-GRASP-STANDING FOOT-BENDING AND -STRETCHING.—The patient stands on a stool in Reach-grasp-st. position, places one foot so that the heel is supported close to the edge of the stool, while the anterior part of the foot lies beyond it. The operator, in Half-knee-standing position (on one knee) at the side

FIG. 56.

of the patient, grasps with one hand (the inner) the patient's heel to fix the foot, while with the other hand he resists the movement, which, as in the preceding, is finished by a passive dorsal flexion.

FREE-STANDING 2 (DOUBLE) FOOT-BENDING AND -STRETCHING = ALTERNATE TOE- AND HEEL-RAISING.—The patient raises alternately the heels and toes (front part of the foot) as high as possible from the ground.

Practised at first in Reach-grasp-standing position, later in Wing-standing.

(*N.B.*—No flexion in hip or knee joints. Movement takes place in ankle joint (astragalo-tibial joint).)

The working muscles are :—

For *flexion* (dorsal flexion), muscles in front of leg; for *extension* (plantar flexion), muscles at back of leg (calf muscles).

Special Effects.—(*a*) Blood supply, metabolism, and production of heat in the feet and legs are increased.

(*b*) Depletes the head and upper part of the body, especially if given double.

Uses.—1. For cold feet and legs.

2. After massage of these parts, to increase the flow of arterial blood and fresh fluid to the tissues.

3. As a gentle leg exercise in general gymnastic treatment.

The Effects of the various Starting Positions.—(*a*) HALF-LYING position allows the effect of the exercise to be as pure as possible.

(*b*) HIGH-REACH-GRASP-STANDING is slightly harder, because many muscles must work for maintaining the position. Seldom used.

(*c*) In FREE-STANDING position the resistance is made by the weight of the patient's own body, and consequently cannot be modified.

HALF-LYING FOOT-INVERSION (= SUPINATION) AND -EVERSION (= PRONATION).—The position of the gymnast and the grasp is similar to Half-lying Foot-bending-stretching, but the grasp is modified so that the resistance acts on the sides of the feet. The foot is kept strongly dorsally flexed throughout, in order that the astragalus may be fixed by its anterior broad surface being pressed between the malleoli, and the movement thus limited as much as possible to the tarsal joints. The movement is usually given so that the muscles work concentrically, but if the pronators or supinators alone are to be exercised it is then done so that they work concentrically and eccentrically, and usually only in the inner part of the range of movement, *i.e.*, the patient does pronation or supination as far as possible against the resistance of the gymnast, who then turns the foot back to the starting position, *but no further*, against the resistance of the patient. Repeated five to eight times.

The working muscles are :—

In *eversion*, the Peronei; in *inversion*, chiefly Tibialis Anticus and Postieus.

Effects and Uses.—(*a*) Principally as in Foot-bending-stretching.

(*b*) Inversion only is used in flat foot.

(*c*) Eversion only in treatment of club foot and in paralysis or paresis of the Peronei.

Half-lying
Sitting } *Foot-rolling.*

HALF-LYING FOOT-ROLLING (PASSIVE) (Fig. 57).—Gymnast's position and placing of foot similar to Foot-bending-stretching. With one hand the leg is fixed just above the heel; the other

hand grasps the foot from the plantar side at the metacarpo-phalangeal joints and carries it round in as large circles as possible fifteen to twenty times each way. The movement is completed either by a passive flexion with overstretching or by an active Foot-bending-stretching against resistance. Foot-rolling can of course be done actively (without resistance).

If the movement is quite double 2 Foot-roll. the gymnast places himself in front of the patient, as in 2 Foot-bending-stretching, or it may be done by two gymnasts. (*N.B.*—Both feet must be rolled at the same time inwards or outwards (not one in, the other out).)

Sitting Foot-rolling.—Is done actively by the patient, without resistance. Heels supported on the ground.

Foot-rolling takes place chiefly in the astragalo-tibial and astragalo-calcaneo-scaphoid joints, but also in the other joints of the foot and in the hip joint more or less.

Fig. 57.

Effects and Uses.—Passive Foot-rolling loosens the joints and increases their mobility, and increases circulation in the foot (by alternate lengthening and shortening of the vessels). It is used, therefore, in treatment of all kinds of stiffness in the joints of the foot, in treatment of heart disease, and in coldness of feet and legs.

In active Foot-rolling all the muscles of the leg are brought into action, and its effects are therefore almost the same as the effects of active Foot-bending-stretching.

Movements in the Knee Joint.

Half-lying
Wing-half-sitting
Sit-lying
Forward-lying
} *Knee-bending and -stretching.*

Half-lying Knee-bending and -stretching (Fig. 58).—The gymnast sits at the side of the patient and places the patient's leg over his own knee so that the knee can be freely bent. The gymnast's one hand fixes the thigh at the knee; the other gives resistance above the ankle to stretching, just above or at the heel to bending. Patient bends and stretches the knee; resisted by

the gymnast four to six times. The movement is completed by gentle passive over-stretching with slight shaking. Usually given in this way, but can be given so that the muscles work concentrically and eccentrically.

May also be given as a passive movement (*Knee-pumping*). The grasp is then either above the ankle or on the lower part of the leg just above the malleoli.

Fig. 58.

Wing-half-sitting Knee-bending and -stretching. — Is carried out in the same way as the previous exercise, but the gymnast stands at the side of the patient, whose thigh rests on the apparatus (boom or high plinth).

Sit-lying 2 (Double) Knee-bending and -stretching (Fig. 59).—The gymnast fixes the patient's knees with one hand, while with the other he gives resistance at the feet.

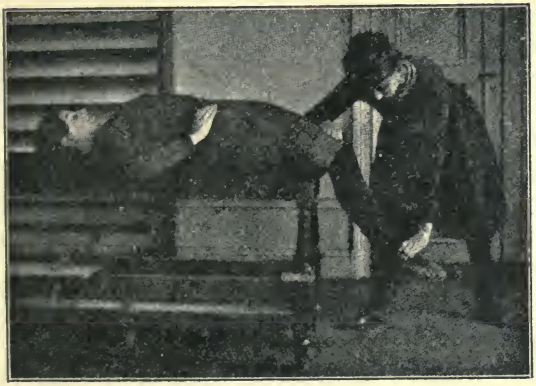

Fig. 59.

Forward-lying 2 Knee-bending and -stretching. — The gymnast stands at the side of the patient and fixes his thighs with one hand just over the knees, while with the other he resists at the feet. Movement takes place in the knee joint.

The working muscles are :—

In *bending*, muscles at back of thigh (Semi-tendinosus, Semi-membranosus, and Biceps Femoris, and, to a certain extent, also Gastrocnemius).

In *stretching*, muscles in front of thigh (Quadriceps Femoris).

Special Effects and Uses.—(*a*) Repleting to thigh muscles, and, according to Major Brandt, also slightly repleting to pelvis.

(*b*) Depleting from head and upper part of body.

Used specially after massage of thigh or knee joint, and in

general gymnastic treatment as a good leg exercise, which can be easily modified to suit the patient's strength.

The Effects of the various Starting Positions.—Half-lying position makes the effect of the movement as pure as possible, while the strength can be modified as required.

Half-sitting is somewhat harder, partly because a good deal of muscle action is necessary to maintain the position, partly because the origin and insertion of Rectus Femoris approach one another, so that the power of the muscle is diminished and stretching is more difficult.

Sit-lying facilitates stretching because the origin and insertion of Rectus Femoris are separated, and so the power of the muscle is increased. Because the movement is always (or usually) done double in this position, its depleting effect from the head is greater. Used really only for children (uncomfortable for older patients).

Forward-lying position likewise is only used for children. Comfortable for gymnast; saves time.

Passive Knee-bending and -stretching or Knee-pumping.—Loosens the joints and helps circulation. Used for stiffness in the joint and in paralyses to maintain mobility in the joint.

Movements in the Hip Joint.

A. Exercises with Work chiefly for Flexors.

All these movements give work also to the abdominal muscles, but because the leg is the part moved they are called Leg movements.

Reach-grasp-standing
Wing-standing } *Alternate Knee-raising.*

Without altering the position of the body the legs are lifted alternately as high as possible by flexion in the hip joint, while the knee is passively flexed and extended by the weight of the leg. The knee is carried in the plane of the foot from the starting position. The leg ought always to be perpendicular and the foot plantar flexed when it does not rest on the ground. The movement is repeated ten to twenty times. Beginners as a rule use Reach-grasp-standing position.

The working muscles are :—

(*a*) For performing the movement itself, flexors of the hip joint (concentrically and eccentrically).

(*b*) For fixing the origin of these on the pelvis, the abdominal muscles and the extensors of the supporting leg (statically).

(*c*) To fix the origin of the abdominal muscles, the inspiratory muscles, but not the diaphragm (statically).

(*d*) To prevent the body falling forward, the back muscles (statically).

Effects and Uses.—(*a*) Because the muscle action is so complicated the exercise is good for the nervous system and innervation; this effect is increased by the balancing required for the movement. On this account it can be used in treating disturbances of innervation, *e.g.*, chorea, diseases of the spinal cord, etc.

(*b*) As the abdominal muscles are used it aids peristalsis, but at the same time it impedes respiration, so that it should not be used for weak patients.

(*c*) Finally, the movement may be used as a strong combined leg and abdominal exercise in gymnastic training.

Lying
Half-lying
Str.-grasp-lying
Str.-grasp-standing
Str.-hanging (2) *double*
} *Knee-updrawing and -downpressing.*

Lying Knee-updrawing and -downpressing.—The gymnast stands at the side of the patient and lays one hand as support on his shoulder, while the other is placed upon his knee to give resistance to the exercise.

The patient draws up the knee, resisted by the gymnast, who, when the patient has taken it as far as he can, presses it up passively towards the shoulder as far as possible, after which he presses it back to the starting position while the patient resists.

Repeated three to five times. May be given double by two gymnasts.

Half-lying or Stretch-grasp-lying Knee-updrawing and -downpressing.—Like the preceding.

Stretch-grasp-standing Knee-updrawing and -downpressing (Fig. 60).—Best taken at the wall-bars. Given almost like the preceding, but support is given in the lumbar region instead of at the shoulder.

Stretch-hanging 2 (Double) Knee-updrawing and -downpressing.—Like the preceding, but double. May be given by one gymnast.

The working muscles are :—

Flexors of hip joint (concentrically and eccentrically); abdominal muscles (statically to fix origin of flexors of hip).

If the movement is done double it also takes place in the joints of the lumbar spine, and the abdominal muscles work concentrically and eccentrically.

Effects and Uses.—(*a*) Strongly repleting to the abdominal and especially to the pelvic organs (according to Brandt).

(*b*) Aids peristalsis.

Fig. 60.

(*c*) Impedes respiration; is therefore avoided for weak patients.

(*d*) Taken double it counteracts lordosis, because the abdominal muscles then contract as much as possible.

Effects of the various Starting Positions.—Lying and Half-lying positions make the effect of the movement as pure as possible. The latter makes the exercise slightly more difficult, because the origin and insertion of the flexors of the hip are rather nearer together at the beginning of the movement.

Stretch-grasp-lying and Stretch-grasp-standing involve work for many arm and shoulder muscles (statically), so that the movement becomes more complicated, but at the same time easier, because the origin of the working muscles is fixed.

Stretch-hanging is still more difficult and further impedes respiration.

Lying
Stretch-lying } *Leg-lifting and -downpressing.*

The gymnast stands at the side of the patient and resists at the feet. The patient raises the leg against the resistance of the gymnast, who then presses it down to the starting position against the resistance of the patient. Can be given double.

(*N.B.*—If the movement is given for lordosis, the patient should carry the legs up as far as possible, so that the abdominal muscles perform their maximal contraction.)

Leg-raising is practically similar to Knee-updrawing, but is distinguished from it because the leg or legs are kept straight, so that Quadriceps Femoris also works (statically). The movement becomes still harder because the centre of gravity of the legs is brought further away from the hip joint, and because the gymnast's leverage becomes longer. The resistance should be very slight.

High-ride-sitting Backward-falling, Sit-lying Raising, and High-ride-sitting Backward-drawing all take place in the

hip joint, and give work chiefly for the same muscles as the other movements of this group, though with the attachments reversed, but they are classified as trunk movements, and described as such, because the trunk is the part moved (see Movements for Abdominal Muscles).

B. Combined Flexion in Hip and Knee Joints.

Half-lying
Stretch-grasp-lying } *Leg-updrawing and -downdrawing.*
Short-sitting

Half-lying Leg-updrawing and -downdrawing.—The gymnast stands in front of the patient and grasps with one hand the patient's foot (sole or heel); the other is laid upon the knee. The patient draws up the leg against the resistance of the gymnast, who then draws it back to the starting position against the resistance of the patient. Can also be given as 2 (double) Leg-updrawing and -downdrawing. The gymnast grasps the patient's ankles just above the malleoli.

Fig. 61.

Stretch-grasp-lying and Short-sitting 2 Leg-updrawing and -downdrawing (Fig. 61) are always given double. Short-sitting is taken by the patient sitting on the very edge of a high plinth. An assistant sits in Ride-sitting position behind and fixes him by grasping his shoulders from below.

The working muscles are :—

(*a*) The same as in Knee-updrawing and -downpressing.

(*b*) Flexors of the knee (concentrically and eccentrically).

Effects and Uses.—(*a*) Similar to Knee-updrawing and downpressing, but the effect is rather stronger because more muscles work.

(*b*) Because so many muscles are brought into action at the same time the movement becomes a good one for co-ordination, especially done double, and is used therefore in treating chorea and other diseases where there is disturbance or uncertainty of co-ordination.

Effects of the Starting Positions.—Half-lying and Stretch-grasp-lying have the same effect as in Knee-updrawing.

Short-sitting is most difficult. It is used especially when the movement is given for lordosis.

C. Movements chiefly for Extensors of Hip.

Back-lean-standing Leg-forward-drawing and -backward-carrying (Fig. 62).—The patient stands with back supported against a wall, usually on a stool. The gymnast stands in front of him and fixes the pelvis with one hand over the Ant. Sup. Iliac spine; with the other hand he grips the patient's leg just above the ankle joint, and so draws the leg forward against the resistance of the patient, who then carries it back to the starting position against the resistance of the gymnast. Repeated four to six times. Can also be taken in Lying position. (*N.B.*—The supporting leg must not be bent at the knee during the movement.)

Fig. 62.

The working muscles are :—

Extensors of hip (eccentrically and concentrically).

Effects and Uses.—Depleting from the pelvis (according to Brandt).

To this group belong really also High-ride-sitting Backward-bending and Back-raisings, but because in these movements the trunk is the part moved they are described with trunk movements (see Movements for Extensors of Trunk).

D. Combined Extension in Hip and Knee.

Half-lying (really Half-crook-half-lying) Leg-out-stretching (Fig. 63).—The gymnast stands at the side of the patient and grasps with one hand the dorsum of the foot; with the other the heel from below. At the same time he leans his shoulder against the patient's knee, and during the movement resists partly with the shoulder, partly with the hand which holds the heel, while the hand which grasps the dorsum of the foot guides the movement.

The patient stretches the leg against the resistance of the gymnast, who then carries it back to the starting position while the patient is either quite passive or gives a little resistance. Repeated four to eight times.

If the movement is given with slight resistance a similar grasp is used as for Leg-updrawing and -downdrawing.

The working muscles are :—

(*a*) Extensors of hip (concentrically, then eccentrically). (*N.B.* —Semi-tendinosus, Semi-membranosus, and Biceps do *not* work.)

(*b*) Extensors of knee (concentrically, then eccentrically).

(*c*) Lower part of extensors of back (statically to fix pelvis).

Effects and Uses.—(*a*) Depleting from head and upper part of body.

(*b*) Used in general gymnastic treatment as a good leg exercise, and after massage of thigh and region of hip to cause increased supply of blood to the muscles worked upon.

Fig. 63.

Wing-knee-sitting Raising and Downpressing. — Knee-sitting position is derived from Knee-standing by bending hip and knee joints till the buttocks rest on the heels.

The patient takes up the position on a plinth ; the gymnast, standing behind him, places his hands on the patient's hips (iliac crests) and gives resistance while the patient raises himself to Knee-standing position. Then the gynmast presses down the patient again to starting position, while he in his turn resists. Repeated four to six times. (*N.B.*—Trunk should be kept upright throughout.)

The working muscles are the same, as in the previous exercise, but their attachments are reversed.

Effects and Uses.—Are naturally also similar, but the exercise is not much used because it cannot be so well moderated (is always double ; resistance can never be less than the weight of the patient's own body).

E. Combined Extension in Hip, Knee, and Ankle.

Reach-grasp-standing
Reach-grasp-instep-support-standing
Wing-standing
Neck-rest-standing
Stretch-standing
Stretch-instep-support-arch-standing

} *Heel-raising Knee-bending.*

Reach-grasp-standing Heel-raising Knee-bending (Fig. 64). —After having taken the position, the patient first performs

"*Toe-heaving*," or more correctly "Heel-raising," then "*Knee-bending*" to a right angle between thigh and leg, then "*Upward-stretching*" to Toe-standing, and finally "*Sinking*" to starting position.

Fig. 64.

The exercise is performed at the command of the gymnast ("heels raise, knees bend, upward stretch, sink"); and he must observe that the carriage of the body is carefully maintained throughout. Repeated four to five times.

Sometimes the exercise is combined with "*abdominal and lumbar pressure*." This is given with the gymnast's one hand placed on the patient's sacrum, the other just above the symphysis pubis. In stretching, which is usually combined with a marked arching forward of the pelvis while the patient's arms are kept fully extended, the gymnast presses both hands firmly towards each other. In this it must be carefully observed, especially with women patients, that the palmar surface of the front hand is turned slightly upwards and that pressure with this is exerted straight backwards, not in the slightest degree down towards the true pelvis, otherwise dangerous pressure on the genital organs may occur.

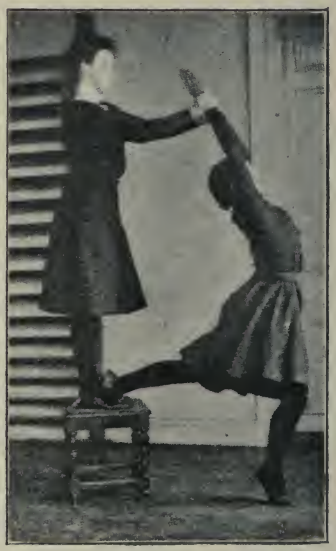

Fig. 65.

Reach-grasp-instep-support-standing Heel-raising Knee-bending. — Like the preceding; repeated three to four times on each leg. May be combined with abdominal and lumbar pressure.

Wing-standing and Neck-rest-standing Heel-raising Knee-bending. — Performed like Reach-grasp-standing, but in Free-standing position.

Stretch-standing Heel-raising Knee-bending.—The gymnast stands in front of or behind the patient, grasping his wrists, and resists the upward stretching.

STRETCH-INSTEP-SUPPORT-ARCH-STANDING HEEL-RAISING KNEE-BENDING (Fig. 65).—The gymnast stands behind the patient on a stool. The patient holds one leg stretched backwards as straight as possible, with the foot supported on a stool. Otherwise like the preceding, except that the patient on stretching upward pushes forward the pelvis so that a strongly arched position arises.

The working muscles are :—

(*a*) Extensors of hip.

(*b*) Extensors of knee.

(*c*) Plantar flexors of ankle (calf muscles). They all work eccentrically and concentrically. (*N.B.*—Really the calf muscles work first concentrically, then eccentrically, concentrically, and finally eccentrically.)

Effects and Uses.—Chiefly like Leg-outstretching, but Heel-raising and Knee-bending is in all respects stronger. It can only be moderated to a certain extent, because the weight of the body must always be overcome. It also repletes the pelvis (according to Brandt), probably because the common iliac arteries are enlarged to make possible the increased supply of blood necessary to the working muscles of the lower extremity.

Effects of the various Starting Positions.—(*a*) REACH-GRASP-STANDING facilitates the movement, partly because balancing is unnecessary, partly because the patient can help with the arms.

(*b*) REACH-GRASP-INSTEP-SUPPORT-STANDING causes double work for the muscles, because the whole weight of the body is carried by one leg. But it is not so strongly depleting from the head, nor so strongly repleting to the pelvis.

WING-STANDING is more difficult than the preceding, partly because balancing is necessary, and partly because there is no help from the arms.

STRETCH-STANDING is still stronger because of the resistance given in rising. Used in treatment of scoliosis to educate the sense of correct holding of the back (it is then performed slowly and with careful correction of the holding, but with little or no resistance).

STRETCH-GRASP-ARCH-INSTEP-SUPPORT-STANDING is the strongest. It is often used by Brandt when a strongly repleting effect on the pelvis is desired (arch position combined with strong work for leg muscles).

ABDOMINAL AND LUMBAR PRESSURE produces a mechanical stimulation of the walls of the alimentary canal, so that peristalsis is increased.

F. Combined Flexion and Extension in Hip.

High-reach-grasp-standing
Side-grasp-standing (really half-wg., half-yd.-gr.-st.) } *Leg-swinging forward and backward.*

High-reach-grasp-standing Leg-swinging.—Patient stands on a stool by the boom or peg-post, and swings first one leg and then the other several times forward and backward as far as possible. The supporting leg must be held straight and the trunk erect.

Side-grasp-standing, Leg-swinging.—Performed like the preceding, but patient generally stands on the floor and swings the leg nearest to the support. When the leg swings forward the movement takes place in the hip joint of the moving leg, but when it swings back to or slightly behind the frontal plane the movement takes place in the hip of the supporting leg, while a compensating bending in the lumbar spine (with convexity forward) allows the trunk to maintain the upright position. The movement thus takes place in both hip joints and the joints of the lumbar spine.

Fig. 66.

The working muscles are :—

(*a*) Flexors and extensors of the hip joint.

(*b*) Abdominal muscles.

(*c*) Muscles of lumbar region of spine.

Effects and Uses.—(*a*) Because muscular action is facilitated by the pendulum movement of the leg, it is not so strong, and on this account the movement is used when the strength of the muscles for some reason is lowered, *e.g.*, in treating paralyses.

(*b*) Mobility of the joints is increased.

High-reach-grasp-standing Leg-backward-drawing and forward carrying (Fig. 66).—The gymnast stands behind the patient and lays one hand on the hip of the moving leg for support, and with the other grasps the ankle at the malleoli. The gymnast draws back the leg against the resistance of the patient, who then carries the leg forward a foot-length or more in front of the supporting leg, against the resistance of the gymnast. Repeated three to five times with each leg. Patient's arms

and legs held straight throughout the movement and the trunk erect.

The movement takes place chiefly in the hip of the supporting leg and in the joints of the lumbar spine; only the last part takes place in the hip of the moving leg.

The working muscles are :—

(*a*) The extensors of the knee of the moving leg (statically), to keep the knee extended.

(*b*) The extensors of the hip of the supporting leg (eccentrically and concentrically).

(*c*) Abdominal muscles, especially the straight and the oblique (eccentrically and concentrically).

(*d*) Flexors of hip of moving leg (concentrically and eccentrically).

Effects and Uses.—Because the abdominal muscles work it aids peristalsis somewhat, but otherwise the exercise has no special effect. It is used as a combined abdominal and leg exercise in general gymnastic treatment.

G. Movements chiefly for Abductors of Hip.

Crook-half-lying Knee-parting and -inpressing (Fig. 67).—The gymnast stands at the side of the patient's knees or in front of his feet and puts his hands on the outer side of the knees. The patient carries the knees outward against the resistance of the gymnast, who then presses them together against the resistance of the patient. Repeated four to six times.

Fig. 67.

It is sometimes combined with "*Pelvis-lifting*," which is performed by the patient strongly extending both hips, raising the pelvis so that he comes to rest upon the plinth, supported only by the neck and upper part of the back and the feet. The movement is then performed in this position.

The working muscles are :—

Glut. Med. and Min., but the Gemelli and Pyriformis also take part. They work concentrically and eccentrically. It depletes

the abdominal and pelvic organs, especially when combined with Pelvis-lifting, because this causes strong work for the extensors of the hips and back.

Half-lying)
Hanging) *Leg-parting and -inpressing.*

HALF-LYING, LEG-PARTING AND -INPRESSING.—The gymnast stands in front of the patient and grasps him at the ankles. The patient carries the legs outward against the resistance of the gymnast, who then presses them together against the resistance of the patient. Repeated three to six times.

FIG. 68.

If two gymnasts are working (Fig. 68) they stand at the side of the patient's legs, which are supported against their thighs. They should be so placed that the movement can be performed without the foot which supports the patient's leg being moved from its place.

It is only distinguished from the preceding movement in that the gymnast has a longer lever. It is used, therefore, for strong patients.

HANGING LEG-PARTING AND -INPRESSING.—Practically similar to the preceding. Used for children in scoliosis treatment.

FIG. 69.

HIGH-REACH-GRASP-STANDING LEG-OUTWARD-CARRYING AND -INPRESSING (Fig. 69).—The patient stands in Reach-grasp-standing position on a stool in front of the wall-bars, boom, or peg-post. The gymnast stands behind and steadies the patient's hip with one hand (best to steady the hip of the supporting leg), and with the other he resists the foot of the moving leg. The patient carries the leg straight out to the side against slight

resistance by the gymnast, who then presses it back to the starting position against the resistance of the patient. Repeated three to five times with each leg.

The movement takes place not only in the hip of the moving leg, but also in that of the supporting leg and in the joints of the lumbar spine.

The principal working muscles are :—

(*a*) Abductors of moving leg.

(*b*) Abductors of supporting leg.

(*c*) The side muscles of the trunk in the lumbar region on the side of the moving leg (all concentrically and eccentrically).

Effects and Uses.—(*a*) Depletes pelvis.

(*b*) Given on one side it is used for a lumbar curve.

H. Movements chiefly for Adductors of Hip.

Crook-half-lying Knee-closing and -outdrawing.—The gymnast places his hands on the inner sides of the patient's parted knees and resists while the latter brings them together, and then the gymnast presses them outward while the patient resists. Repeated three to five times.

Sometimes combined with "*Pelvis-lifting*" (see Knee-parting and -inpressing).

Effects and Uses.—(*a*) Repletes pelvis (Brandt).

(*b*) If the movement is combined with "*Pelvis-lifting*" its repleting effect is counteracted. Moreover, by associated movement, the muscles of the pelvic floor are brought into action (Levator and Sphincter Ani, Transversus Perinei, and Sphincter Vesicæ). Used on this account for slackness of these muscles.

Half-lying Leg-closing and -outdrawing.—Usually given by two gymnasts. These place themselves in the same way as for Leg parting and -inpressing. The gymnasts resist when the legs are carried together, and then draw them apart against the resistance of the patient.

Effects and Uses.—Same as in preceding exercise, but the gymnast has a longer lever ; hence movement is harder.

I. Combination of Abduction and Adduction in Hip.

Reach-grasp-standing Leg-side-swinging.—Performed in the same way as Leg-swinging-forward and -backward, but the leg is swung to the side.

Effects and Uses.—Similar to above exercise.

Crook-half-lying Knee-parting and -closing.—The gymnast resists while the patient alternately carries the knees outward and

inward. Repeated four to eight times. Finished by knee-inpressing against resistance of patient.

The abductors and adductors of hips work concentrically.

Effects and Uses.—Neither repleting nor depleting to pelvis; only strengthening of muscles. Used as a good leg exercise in general gymnastic treatment.

Half-lying Leg-abduction and -adduction.—Like the preceding, but the gymnasts (usually two) resist at the feet. Finished with Leg-inpressing against the resistance of the patient.

Effects and Uses.—Also similar to preceding, but stronger.

K. Movements for Rotators of Hip.

Half-lying Leg-rotation (Fig. 70).—The gymnast's position and grasp is similar to that for Foot-rolling.

The patient turns the leg alternately in and out against the resistance of the gymnast at the sides of the feet by the metacarpo-phalangeal joints. The patient's foot must be held strongly flexed throughout. The movement may be given for the outward or inward rotators only, in which case the muscles usually work concentrically and eccentrically and in the inner half of the range of movement (in shortening). In this case the patient turns the leg respectively out and in as far as possible against the resistance of the gymnast, who then turns the foot and leg back to the starting position, but not further, against the resistance of the patient.

Fig. 70.

The working muscles are :—

For *inward* rotation, the anterior part of Glut. Med. and Min. and Tensor Fasciæ Latæ; for *outward* rotation, chiefly the Gemelli, Obturators, and Quad. Femoris.

Besides exercise for the muscles and joints the movement has no special effect. Outward rotation alone is used for a tendency to turn the feet in.

Rotation of the hip joint also takes place in Wg.-close-standing Alternate Trunk-rotation and in Heave-grasp-close-standing Alternate Hip-rotation and -forward-turning (see Trunk rotation).

L. Combined Flexion, Extension, Abduction and Adduction in Hip Joint.

High-reach-grasp-standing Leg-circling. — The gymnast stands obliquely behind the patient and grasps one foot with both hands, and resists while the patient carries the leg in a large circle forward, outward, backward and forward again to the starting position. Patient's arms and legs held fully stretched throughout and trunk erect. Repeated four to six times with each leg. Can be done also without resistance. Movement takes place in both the hip joints and the joints of the lumbar spine.

The working muscles are :—

(*a*) Most of the muscles round the hip joint.

(*b*) Abdominal muscles.

(*c*) Back muscles, specially of lumbar region.

It is used in general gymnastic treatment and elsewhere when one wishes to exercise the hip muscles.

Half-lying
Stretch-grasp-arch-half-crook-standing } *Leg-rolling.*

Half-lying Leg-rolling (Fig. 71).—Is a passive movement. The gymnast stands in stride-standing position, obliquely in front of the patient, and grasps the sole of the foot with one hand (on the inner side), the other hand under the knee or just below. The knee is carried in as large circles as possible (really semi-circles) upward, outward and downward, while the foot goes straight forward and backward in the sagittal and horizontal plane about the level of the support.

Fig. 71.

In carrying upward one must avoid letting the knee go over the middle line, and at least with women patients the movement is given only in one direction, as described above, to avoid irritation of the genital organs (Brandt). Repeated ten to twelve times.

Sometimes given with vigorous upward swinging of the knee towards the axilla (avoid pushing against the breast), so that the thigh each time exercises pressure on the abdominal wall. In this way it helps peristalsis.

If it is used for stiffness in the hip joint the knee is made to

describe small circles in and around the largest circle which can be made. The movement is then practised in both directions.

Effects and Uses.—Besides the special effects spoken of above, leg-rolling aids circulation in the veins of the leg, and has a strongly repleting effect on the pelvis (Brandt). This last is important to remember, as the movement is largely used in general gymnastic treatment, and may easily cause inconvenience to women patients with a tendency to profuse menstruation.

Stretch-grasp-arch-half-crook-standing Leg-rolling.—Given by two gymnasts standing one on each side of the patient, on whose sacrum they each lay a hand, whilst they grasp his knee with the other. The leg is carried in circles in the same way as in the preceding. The foot hangs down loosely. Repeated eight to ten times, first with one, then with the other leg. Usually finished by single knee adduction concentrically and eccentrically and knee-updrawing and -downpressing in the same position.

Used by Thure Brandt as a strongly repleting movement to the pelvis.

Arm Movements.

Besides the general effects of active movements, arm movements as a rule deplete the internal organs. Many of them directly aid respiration, and consequently circulation. Most movements in the shoulder joints also develop the thorax and correct the position of the shoulders. If they are given with strong resistance, as a rule they somewhat impede respiration, because the thorax is contracted to give the working muscles firm origin.

Fig. 72.

Movements in the Finger Joints.

Sitting (or Half-lying) Finger-bending and -stretching (Fig. 72).—The patient's elbow is supported on the gymnast's knee, or on a high plinth or other suitable apparatus. The gymnast fixes the patient's wrist with one hand and with the other gives resistance to the movement, while the patient alternately bends and stretches the fingers.

(*N.B.*—In flexion the last phalanx must be bent first; in extension the first phalanx must be extended first. Repeated six to eight times.)

If not otherwise stated, the movement is always done as described, *i.e.*, so that the muscles only work concentrically. Also given passively.

The working muscles are :—

(*a*) Interossei and Lumbricales.

(*b*) The flexors and extensors of the fingers on the forearm.

Effects and Uses.—(*a*) Supply of blood, metabolism, and production of heat in the forearm and hand increased, so that the movement is used for cold hands and after massage of the hand or forearm.

(*b*) Innervation to muscles of fingers is exercised. Used, therefore, in treatment of writer's cramp and similar trade neuroses and other disturbances of innervation.

(*c*) Loosens the joints, and on this account is largely used in after-treatment of fractures of forearm, teno-synovitis, joint diseases, etc.

Standing, *Sitting* } *Finger-stretching.*

Free Movement. While the fingers are alternately stretched and bent they are at the same time separated and closed.

Takes places in the same joints as the preceding; almost the same muscles work; effects and uses similar.

Sitting, *Half-lying* } *Finger-rolling.*

Passive Movement. The gymnast fixes the patient's metacarpal bones (not the thumb) with one hand, and with the other grasps the four fingers, which are rolled (circumducted) in both directions in the metacarpo-phalangeal joints.

Used for stiffness in the fingers.

Movements of Thumb.

Flexion-extension, Abduction-adduction, Opposition, and Rolling are specially given.

Movements in Wrist Joint.

Sitting, *Half-lying* } *Wrist-bending and -stretching* (Fig. 73).

The patient's forearm is supported on the gymnast's knee, on a plinth, or in some other way.

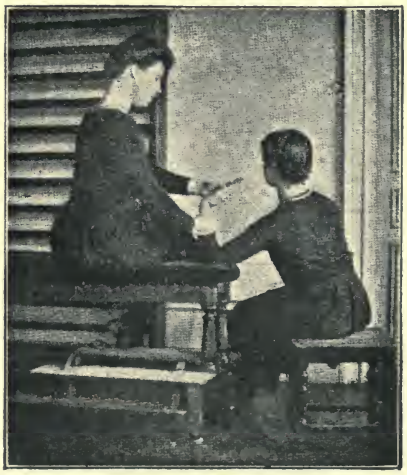

FIG. 73.

The gymnast fixes the patient's forearm with one hand immediately above the wrist, and with the other grasps the hand at the meta-carpo-phalangeal joints, and gives resistance to the movement, while the patient alternately bends and stretches the hand. Repeated four to six times.

Fig. 74.

The working muscles are :—

For *palmar flexion* (= bending), most of the muscles on the front of the forearm (concentrically); for *dorsal flexion* (= stretching), most muscles on the back of the forearm.

Effects and Uses.—Like those of Finger-bending and -stretching.

Sitting Radial and Ulnar Flexion (Ab- and adduction).—The position and grasp are similar to the preceding exercises. The patient bends the hand alternately towards the radial and ulnar sides against the resistance of the gymnast.

The working muscles are :—

For *abduction*, Flex. Carpi. Rad. and Ext. Carpi Rad.; for *adduction*, Flex. Carpi Uln. and Ext. Carpi Uln.

Effects and Uses.—Like the preceding.

Sitting Wrist-rolling (Fig. 74).—Passive movement. Position and grasp as in Wrist-bending-stretching. The gymnast rolls (circumducts) the patient's hand in as large circles as possible both ways. Repeated ten to twenty times. Can be done actively.

Effects and Uses (like all rollings).—(*a*) Aids circulation.

(*b*) Loosens joints.

Fig. 75.

Movements in Radio-Ulnar Joints.

Sitting Forearm-rotation (Fig. 75).—(Inward = pronation, outward = supination.)

The patient's elbow is bent to a right angle and supported. The gymnast grasps the patient's hand, and with the other hand presses the elbow against the supporting surface to give steadiness to the movement. The patient rotates the forearm alternately outward and inward against the resistance of the gymnast. Wrist kept well extended. Repeated four to six times.

The working muscles are :—

For *pronation*, Pron. Teres and Pron. Quad. (concentrically); for *supination*, Supin. Brevis and Biceps, and a little at the beginning of the movement Brachio-radialis (Supin. Longus) (concentrically).

No special effect besides exercise of muscles and joints.

Movements in the Elbow Joint.

Sitting Forearm-bending and -stretching (Fig. 76).—One of the gymnast's hands grasps and supports the patient's elbow, the other resists at the wrist, whilst the patient alternately bends and stretches the elbow joint. Resistance may also be given at the middle of the hand, in which case the flexors and extensors of the wrist also take part in the movement (statically to fix wrist). Repeated four to six times.

Fig. 76.

The working muscles are :—

In *flexion*, Biceps, Brachialis Internus (Anticus), and Brachio-radialis (Supin. Longus); in *extension*, Triceps.

Effects and Uses.—No special effect, except exercise of muscles and joints. It is used in general gymnastic treatment as an easy arm exercise and after massage of elbow or arm.

Used often as a passive movement to increase mobility in the elbow joint.

Back-lean-standing 2 (double) Forearm-bending and -stretching.—The gymnast stands in front of the patient and resists at the wrist. The patient holds the arms close to the body.

Movements in the Joints of the Shoulder Girdle.

Movements in these joints are very seldom isolated from each other, but usually take place at the same time in all three joints (humero-scapular, acromio-clavicular, and sterno-clavicular), but for convenience and clearness the various exercises following are referred to the joint in which they chiefly take place.

I. Movements in Humero-scapular Joint.

A. Abduction and Adduction (round the sagittal axis).

Sitting Arm-carrying-outward and -inward.—The patient's arm is flexed to a right angle in the elbow joint. The gymnast with

one hand grasps the patient's hand, with the other gives resistance at the elbow, while the patient alternately carries the arm outward to the horizontal and inward. Repeated three to five times.

Sometimes taken passively to improve mobility in a stiff shoulder. In this case the shoulder is fixed by one of the gymnast's hands or in some other way.

The working muscles are :—

In *abduction :* (*a*) Deltoid (for movement in humero-scapular joint).

(*b*) Serr. Magnus and lower part of Trapezius (on the acromio-clavicular joint). They all work concentrically.

(*c*) Upper part of Trapezius (statically to fix sterno-clavicular joint).

For *adduction :* (*a*) Pect. Major and Lat. Dorsi.

(*b*) Teres Major.

(These work chiefly on the humero-scapular joint.)

(*c*) Rhomboids (on acromio-clavicular joint).

(*d*) Pect. Minor and lower part of Trapezius (work on sterno-clavicular joint).

No special effect besides exercise for muscles and joints.

Used when these are to be exercised, *e.g.*, after paralyses and in treatment of accidents to the shoulder joint.

Standing 2 (double) Arm-lifting-sideways.—Usually taken as a free movement (without resistance). In this only the abductors are used (concentrically and eccentrically).

Effects and Uses.—The chest is expanded as in taking Yard-standing position.

Used on this account as a gentle *respiratory exercise*, which may be taken by the patient himself as a so-called "between movement."

B. Arm-flexion and extension (round the frontal axis).

Standing 2 (double) Arm-lifting-forward-downward.—Usually taken as a free exercise, but can also be a resisted movement. In that case done with one arm at a time, usually in sitting or lying position, and in a similar way to that described for abduction and adduction.

Practically the same effect as the movements of the preceding group. Does not, however, expand the chest.

Standing 2 (double) Arm-swinging-forward (to horizontal plane) and -backward.—Free exercise. Same effect on shoulder as Leg-swinging on hip joint.

C. Rotation (round the vertical axis).

Sitting Arm-rotation-outward-inward (Fig. 77).—If possible the patient's arm must be abducted to horizontal plane. Elbow flexed to a right angle. The gymnast's one hand grasps and supports the elbow, the other gives resistance at the wrist, while the patient turns the arm alternately in and out. Repeated three to six times. Can also be given as passive movement, either with the above holding or with that for single arm-rolling.

Fig. 77.

The working muscles are :—

In *outward rotation*, Infraspinatus and Teres Minor ; in *inward rotation*, Subscapularis, Teres Maj., and Lat. Dorsi.

Effects and Uses.—No special effect besides exercise for muscles and joints.

Combined Rotation in Humero-scapular and Radio-ulnar Joints.

(Half-wing-half-) yard-sitting Arm-rotation with rod (Fig. 78).—The patient grasps the rod (a short one about $\frac{1}{3}$ metre long) in the middle; the gymnast grasps both ends. The gymnast gives gentle resistance while the patient turns the arm alternately out and in. Wrist joint held well extended throughout, and grip of rod must be firm.

Fig. 78.

Used as a good arm exercise in general gymnastic treatment, and especially to exercise muscles of rotation and the joints. (*N.B.*—All movements for fingers, hand, etc., can be given with concentric and eccentric muscle action if specially required.)

D. Rolling.

Sitting Single-arm-rolling (Fig. 79).—Passive movement. The gymnast stands in stride-st. position at the side of the patient, whose arm, flexed to a right angle, he grasps from in front and below so that the thumb lies in the bend of the elbow, while the patient's forearm lies along that of the gymnast. With the other hand he fixes the patient's shoulder (thumb behind, fingers in front). The patient's arm is now rolled (circumducted) in as large circles as possible in both directions. If the gymnast throughout the movement gives a little drawing out in the direction of the upper arm the movement will go better and more comfortably. It is used specially in treatment of stiff shoulder. (*N.B.*—If movement in the humero-scapular joint is very limited, mobility in the other joints of the shoulder may be so increased that they take its place. In this case the shoulder would not be fixed.)

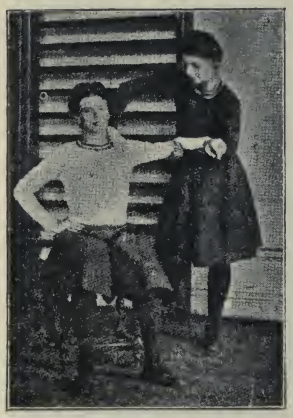

Fig. 79.

2 (double) Arm-rolling (see Combination of Movements in all Joints of Shoulder).

II. Rotation of Scapula in Acromio-clavicular Joint.

Yard-standing
Yard-sitting
Reach-standing
} 2 (*double*) *Arm-lifting and -lowering* (*to horizontal plane*).

Yard-standing and Reach-standing 2 Arm-lifting are free movements.

Yard-sitting 2 Arm-lifting and -downpressing (Fig. 80).—Usually given as a resistance exercise. The gymnast stands behind the patient, whose back he supports with one knee or in some other way, while he grasps the patient's supinated hands at the wrists. The patient carries the arms up to stretch position against the resistance of the gymnast, who then presses them down to the starting position

Fig. 80

against the resistance of the patient. Repeated three to five times.

The working muscles are :—

Serr. Magn., Trapezius, and Deltoid; they work concentrically and eccentrically in shortening (*i.e.*, in the inner part of the range of movement).

Effects and Uses.—Chiefly similar to Arm-carrying-outward-forward, but the muscles are more taxed and the thorax expanded more strongly, especially the lower part.

III. Combination of Movements in all Joints of Shoulder.

St. 2 Arm-carrying-forw.-upw.-outw.-downw. ; St. 2 Arm-carrying-outw.-upw.-outw.-downw.—Free movements. Done in time with breathing three to six times. (*N.B.*—When the arms have reached stretch position the patient makes an attempt to raise them a few centimetres higher. These movements can also be done as *swingings*. They are then done quickly, and their effect is stronger.)

Effects and Uses.—Like the preceding group. Respiratory exercises, which the patient can do by himself as "between movements."

Here I will shortly recall the effects of respiratory exercises on the body :—

(*a*) They increase the supply of oxygen and the output of CO_2, and thus assist the general metabolism in the body.

(*b*) They help the systemic circulation through the increased negative pressure in the thorax accompanying inspiration.

(*c*) They help the systemic circulation by alternate lengthening and shortening of the blood vessels of the lungs and the consequent pumping of blood.

(*d*) They stretch adhesions which may be found between the lung and the thoracic wall, or they prevent the formation of such.

(*e*) They increase mobility in the joints of the ribs, so that respiration is facilitated.

On this account respiratory movements are enormously used in medical gymnastics, both in the treatment of lung and heart diseases and in general disturbances of nutrition. It is an unbroken rule that a table of medical gymnastic treatment must be introduced and finished with a respiratory exercise.

Yard-walk-standing
Yard-fall-standing
Yard-stoop-leg-lean-standing
Yard-stride-sitting
Yard-stoop-stride-sitting
Yard-leg-forward-lying

2 (*double*) *Plane - Arm carrying* (Fig. 81).

The gymnast stands in walk-standing position in front of the patient and grasps his forearms as near the wrist as possible. The patient resists while the gymnast carries the arms forward to " reach " position, and then carries the arms back as far as possible against the resistance of the gymnast.

Fig. 81.

Repeated three to five times. (*N.B.*—Patient's shoulders must be kept low throughout. Arms are carried in the horizontal plane.)

The working muscles are :—

(*a*) For the movement itself, posterior fibres of Deltoid and the back shoulder muscles (Trapezius, Rhomboids, and Lat. Dorsi). They work eccentrically and concentrically in shortening (in the inner part of their range of movement).

(*b*) To maintain the position, and to fix the origins of the above-mentioned muscles, the extensors of the back and hips, statically.

(*c*) Triceps (statically) to hold the elbows extended.

Effects and Uses.—Thorax is expanded and position of the shoulders corrected. It is used especially in treatment of " flat chest," kyphosis and round back, and many deformities of the thorax, also in general gymnastic treatment as a good combined arm and back exercise. It also has a depleting effect on the abdominal and pelvic organs.

Yard-sitting
Heave-sitting
Stretch-sitting
Stretch-half-lying
} 2 (*double*) *Arm-rolling.*

Yard-sitting or high-ride-sitting 2 Arm-rolling (= Circling) (Fig. 82).—The gymnast, standing behind the patient and supporting him in the back, grasps his elbows and carries his arms in large circles forw.-upw.-outw.-downward. Movement is repeated six to ten times and is given in time with respiration, when, as is usually the case, it is given as a *respiratory exercise.* If the circles are made very much larger the movement resembles passive 2 Arm-carrying in sitting position forward-upw.-outw.-downward. It expands the thorax by stretching the Pectorals and Lat. Dorsi.

When the movement is given to *heart patients* the arms as a rule

are not carried above, or only slightly above, the horizontal plane, and not so far backward that any definite fixing of the thorax arises. If it is given *to help circulation* the arms are carried in rather smaller circles and in quicker time. Repeated fifteen to twenty times.

HEAVE-SITTING 2 ARM-ROLLING (= FLYING) (Fig. 83).—The gymnast stands on a stool behind the patient, supporting the back

FIG. 82.

FIG. 83.

with his knee, or more correctly with the front of the lower part of his thigh. The gymnast and the patient grasp each other's wrists and forearms, and the patient's arms are rolled first in one direction and then in the other fifteen to twenty times in rather quick time. Used for aiding circulation and to loosen the joints.

STRETCH-SITTING 2 ARM-ROLLING.—Position of gymnast like the preceding. The patient and gymnast grasp each other's thumbs (really the metacarpal bone of the thumb), and patient's arms are rolled in small circles in both directions. Usually finished by 2 Arm-bd.-str. (*N.B.*—Patient's hands are really only carried straight up and down, the elbows being slightly bent and stretched; at the same time describing a circular path, so that the rolling takes place both in the wrist and shoulder joints.)

STRETCH-HALF-LYING 2 ARM-ROLLING.—Given as the preceding. Both these last forms of the exercise are often used to loosen stiff shoulders.

IV. Combination of Movements in all the Joints of the Shoulder Girdle with Flexion and Extension of Elbow.

Free-standing
Stretch-half-lying
Stretch-stride-sitting
Stretch-stoop-stride-sitting
Stretch-lying, or stretch-sit-lying
Stretch-leg-forward-lying

} 2 (*double*) *Arm-bending and -stretching.*

Free-st. 2 Arm-bending and -stretching.—Free exercise. Usually the arms are stretched in various directions (forward,

Fig. 84.

Fig. 85.

upward, outward, backward and downward). Between each stretching the arms are taken to " bend " position.

Stretch-half-lying 2 Arm-bending-stretching.—The gymnast's position and holding as in 2 Arm-rolling. The patient bends and stretches the arms against the resistance of the gymnast, who at the end of the extension draws strongly upwards without jerking, so that the ribs are raised and the patient compelled to take a deep inspiration. At the end of the downdrawing the gymnast, by suitable pressure on the hands, can press the patient's arms against the sides of the chest, so that expiration becomes more complete. The patient should breathe in during stretching, out during downdrawing. Elbows throughout are carried in the frontal plane. Repeated four to eight times.

Str.-std.-sitting 2 Arm-bending-stretching (Fig. 84).—The

gymnast's position and holding as in 2 Arm-rolling. Given as the preceding exercise.

STR.-STP.-STD.-SITTING 2 ARM-BENDING-STRETCHING (Fig. 85).—The gymnast stands on a stool in front of the patient. They grasp each other's wrists (the gymnast's hands are supinated, the patient's pronated). It is given like the preceding, except that the stretching upwards is not given so strongly. (*N.B.*—The patient must not change the stoop position and other holding during the exercise.)

STR.-LYING AND STR.-SIT-LYING 2 ARM-BENDING-STRETCHING.—Given as Str.-std.-sitting 2 Arm-bending and stretching.

STR.-LEG-FORW.-LYING 2 ARM-BENDING-STRETCHING (Fig. 86).—The gymnast stands in front of the patient. They grasp each

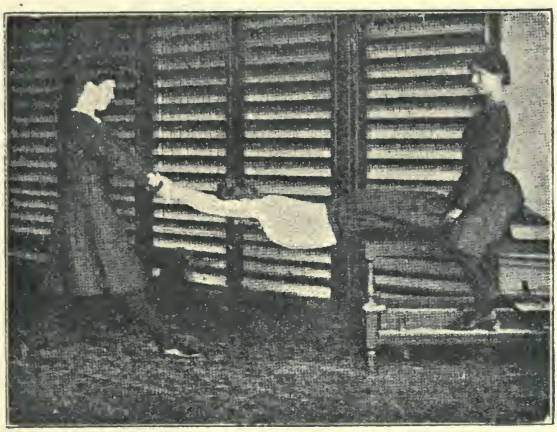

FIG. 86.

other's wrists. Otherwise the exercise is performed in the same way as the exercises already described.

The working muscles are :—

For *flexion* = Arm downdrawing.—(*a*) Flexors of the elbow = Biceps, Brach. Intern. (Ant.), Brachio-Radialis (Supinator Long.), and those muscles of the forearm which arise from the lowest part of the humerus.

(*b*) Adductors of the humero-scapular joint = Pect. Maj., Lat. Dorsi, and Teres Major.

(*c*) Inward rotators of the acromio-clavicular joint (or scapula) = Rhomboids.

(*d*) Muscles which draw the shoulder-blade down (in the sterno-clavicular joint) = Pectoralis Minor and lower fibres of Trapezius. All these muscles work concentrically.

(*e*) Flexors of the fingers work statically to grasp the gymnast's hands.

(*f*) All the muscles which go from the forearm to the hand work statically to prevent too strong stretching of the ligaments of the wrist.

For *upward stretching* of the arms.—(*a*) Extensors of the elbow = Triceps.

(*b*) Abductors of humero-scapular joint = Deltoid and Supra-spinatus.

(*c*) Outward rotators of the acromio-clavicular joint (scapula) = Serr. Magnus and lower fibres of Trapezius.

(*d*) Muscles which raise the shoulder (in sterno-clavicular joint) = upper part of Trapezius.

(*e*) Also the extensors of the back must work statically and on both sides to prevent the spine being bent to either side.

N.B.—Because the elbows are to move in the frontal plane, Lat. Dorsi and the back shoulder muscles must be innervated more strongly than in ordinary stretching and downdrawing of the arms, which helps to improve the carriage of the shoulders.

In this movement nearly all the arm and shoulder muscles are thus brought into action as well as the back muscles.

Effects and Uses.—(*a*) Because of the large number of working muscles the movement is *strongly depleting from the internal organs.*

(*b*) It is used in general gymnastic treatment as a good arm exercise.

(*c*) Aids both inspiration and expiration (for the effects of respiratory exercises see 2 Arm-carry.-outw.-upw.-outw.-downw.).

(*d*) Through the stretching of the spine which arises in down-drawing the back is passively stretched, and by the work of the extensors in upstretching it is actively corrected.

On this account the movement *is used* in the treatment of spinal curvatures, but it must be carefully noticed that the patient really holds the back stretched and straight. Also that patients with severe curves and weak patients only do arm downdrawing and updrawing (concentric and eccentric work for the muscles which draw down the arms).

Contra-indications to the movement are heart disease and severe lung trouble, because a strong expansion of the chest impedes the heart's action, and may also produce severe injury of the lung tissue itself or its surroundings.

The Effects of the various Starting Positions.—Free-st.—Movement is less strong. Used mostly as a between movement, it is much used as a home exercise and in educational gymnastics.

STR.-HALF-LYING.—Makes the effect pure, is most comfortable and most used, but not in treatment of scoliosis.

STR.-STD.-SITTING.—Used specially in treatment of scoliosis, because the holding of the back and work of the back muscles can be more easily controlled. It is also used in treatment in the patient's home and where plinths are not obtainable.

STR.-STP.-STD.-SITTING.—Increases the depleting effect on the internal organs, but does away with its effect as a respiratory exercise.

STR.-LYING AND STR.-SIT-LYING.—Used for children: Str.-sit-lying especially when a strong arm-downdrawing is to be given.

STR.-LEG-FORW.-LYING.—Used in treatment of spinal curvature.

(Half-wg.-half-bend-) stoop-stride-sitting
(Half-wg.-half-bend-) stoop-leg-lean-standing
} *Single Arm-upstretching and -downpressing* (Fig. 87).

The gymnast stands in front of the patient (on a stool if necessary). They grasp each other's wrists: the patient's free hand in wing position, the gymnast's free hand laid on the upper part of the patient's back. The patient stretches up the arm against the resistance of the gymnast, who presses it down against the resistance of the patient. Repeated four to six times. (*N.B.*—In order to obtain the greatest possible effect of the exercise the arm must be stretched as high as possible.)

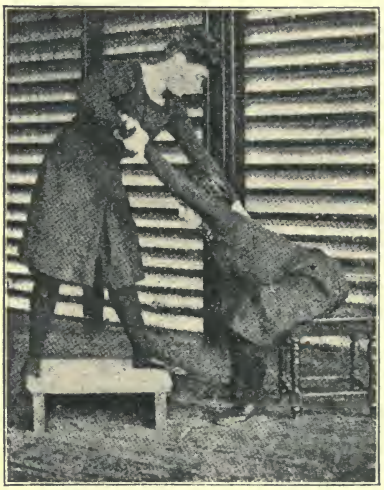

FIG. 87.

The working muscles are:—

(*a*) Same muscles as in Arm-upstretching (concentrically and eccentrically).

(*b*) Extensors of the back, on the opposite side to the stretched arm.

Used in one-sided curvatures in the dorsal region of spine (stretch the arm on the opposite side to the convexity).

Arch-hanging
Fall-hanging
Stretch-hanging
} *Heaving and Sinking.*

From the respective starting position the patient raises himself,

with the help of the gymnast if necessary, to " heave position " (see Heave-hanging starting position) and lowers himself slowly.

The working muscles are the same as in Arm-downdrawing, but with origin and insertion reversed.

Because the resistance is the weight of the patient's own body, the heaving cannot be moderated in any other way than by the gymnast helping the patient, or by lessening the range of movement.

Effects and Uses.—Are chiefly the same as in Hanging and Heave-hanging position. Good active arm exercise in educational gymnastics; corrects carriage of head and shoulders, expands chest, stretches spine, but is hard work and impedes respiration, so can only be used for strong patients.

The Effect of the various Starting Positions.—ARCH-HANGING helps to correct kyphosis, and as well as FALL-HANGING helps to facilitate the movement because the patient has not to raise his whole body weight. STR.-HANGING is the most difficult.

Head and Neck Movements.

These movements take place in the joints between the cervical vertebræ and in the atlanto-occipital joint. Practically they take place round three axes (frontal, sagittal and vertical), so that we divide them into Flexion and Extension (neck-raising) round the frontal, Side-bending round the sagittal, and Rotation round the vertical axis.

Reach-grasp-standing
Reach-grasp-sitting
Hanging
Arch-hanging
Lying
Stretch-leg-forward-lying
Heave-grasp-standing

} *Neck-raising (and eccentric forw.-bending).*

REACH-GRASP-SITTING, OR REACH-GRASP-STANDING, NECK-RAISING (Fig. 88).—The gymnast stands at the side of the patient and lays one hand over his forehead at the roots of the hair; the other grasps the occiput. The patient now carries the head backward against the resistance of the gymnast, who then bends it forward against the resistance of the patient. Repeated five to six times, and is finished by the gymnast, when carrying the head forward for the last time, letting it remain in the starting position.

N.B.—In neck-raising it must be noticed that the patient first holds the chin strongly drawn in and carries the cervical spine back, at the same time raising it vertebra by vertebra. Only

when this is done is the head bent backward in the atlanto-occipital joint, when the chin is carried forward and upward. Forward-bending begins by first stretching the atlanto-occipital joint so that the chin is once again drawn in, when the head is carried forward and downward, so that the chin comes down against the sternum.

Fig. 88.

Hanging-neck-raising (Fig. 89).—The gymnast grasps the patient's occiput with one hand as in the previous exercise; the other supports the patient at the shoulders or abdomen. Sometimes combined with Leg-parting (without resistance), when the patient carries the legs apart at the same time as the head is bent backward.

Arch-hanging Neck-raising. — Like the preceding.

Lying Neck-raising.—The patient lies on the back on a plinth, the head beyond the edge. The gymnast, sitting, grasps the back of the patient's head with both hands. Movement similar to the preceding.

Fig. 89.

Str.-leg-forw.-lying Neck-raising (Fig. 90).—The gymnast, in walk-standing position in front of the patient, grasps his occiput with both hands, while the patient's hands are supported on the gymnast's shoulders.

Hips-firm (or Wing-)st. / *Heave-grasp-st.* } *Neck-raising.*

The gymnast stands in front of the patient, grasps his occiput with both hands, and supports his elbows against the patient's shoulders during the movement.

The working muscles are:—

(*a*) Those muscles which go from the upper dorsal vertebræ to the cervical vertebræ (Cervicalis Ascendens, Transversalis Cervicis, etc.).

(*b*) Those muscles which go from the upper dorsal vertebræ and cervical vertebræ to the occiput (Splenius Capitis, Trachelo-Mastoid, Complexus, Rect. Capitis Posticus Major and Minor, etc.).

(*c*) Trapezius.

Effects and Uses.—(*a*) Because the blood supply to the working muscles is increased, the movement depletes the head. It is also given after massage to the neck muscles.

(*b*) Joints of the cervical vertebræ are loosened.

(*c*) Carriage of the head is improved because the neck muscles are strengthened and shortened. On this account it is used in treatment of kyphosis. (*N.B.*—When the last effect is aimed at

Fig. 90.

the forward-bending must be taken only to the starting position so that the muscles only work "in shortening.")

The Effects of the various Starting Positions.—Reach-grasp-sitting and Reach-grasp-standing fix the trunk well. Most used.

Lying also fixes the trunk very well. Used for children.

Str.-leg-forw.-lying, Hanging, and Arch-hanging are used in treatment of spinal curvatures.

Free-standing
Reach-grasp-standing
Reach-grasp-sitting
Lying
Crutch-standing
Talk-grasp-standing
} *Head-side-bending* (*and -raising*).

Free-standing Head-side-bending.—Free exercise. The gymnast bends the head alternately to each side. (*N.B.*—Avoid rotation.)

Reach-grasp-standing and Reach-grasp-sitting Head-side-bending (and -raising).—The gymnast stands behind the patient and grasps his head at the temples. The movement itself may be done in three different ways.

(*a*) The patient bends the head alternately to right and left three to six times against the resistance of the gymnast.

The muscles work concentrically, and the whole range of movement is traversed. This form is used when the only object is to exercise muscles and joints.

(*b*) The gymnast bends the head to the side against the resistance of the patient, who then raises it to the starting position against the resistance of the gymnast. Movement is repeated three to six times to each side.

Muscles on the convex side of the cervical spine (= that side from which the flexion takes place) work eccentrically and concentrically in lengthening, *i.e.*, in the outer part of the range of movement. It is used when one wishes to exercise innervation to the muscles, *e.g.*, in the treatment of chorea, etc.

(*c*) The patient bends the head to the side against the resistance of the gymnast, who then takes it back to the starting position against the resistance of the patient.

Muscles on the side of the cervical spine towards which the flexion takes place work concentrically and eccentrically in shortening, *i.e.*, in the inner part of the range of movement. This form is used when one specially wishes to shorten the muscles of one side. Naturally given to one side only.

Lying Head-side-bending.—Patient on the back as for Neck-raising. The movement is carried out in the same way as the preceding.

Crutch-standing and Talk-grasp-standing, Head-side-bending.—Given in the same way as Reach-grasp-st. Head-side-bending. They are used in treatment of curves in the cervical region.

Standing
Reach-grasp-standing
Reach-grasp-sitting
Lying
} *Head-rotation* (Fig. 91).

Given and used in the same way as Head-side-bending in the corresponding positions, except that rotation is done instead of bending.

Hips-firm-standing
Reach-grasp-standing
Reach-grasp-sitting
Lying
} *Head-rolling.*

Hips-firm (or Wing-st.) Head-rolling.—Free exercise. The patient rolls (circumducts) the head both ways eight to twelve

times. (*N.B.*—Movement must be taken to the extreme limit of the range of movement. Rotation of head avoided.)

Fig. 91.

All the muscles of the neck take part in the movement.

Used for neck rheumatism and stiffness.

Reach - grasp - st. and Reach - grasp - sitting, Head-rolling. — Usually passive. The gymnast's position and grasp, as in Neck-raising. Movement may be done in two ways:—

(*a*) Like the preceding (as large circles as possible, evenly and smoothly). Usually finished by Neck-raising. *Used* in this way partly to loosen the joints of the cervical spine, partly to help the venous circulation of the neck and thus deplete the head.

(*b*) Beginning with small circles which by degrees get larger and then smaller again, when the time, originally rather slow, becomes very slow indeed. About twenty circles each way. No neck-raising to follow. This modification is used in treatment of sleeplessness.

Lying Head-rolling.—Position and grasp similar to Lying Neck-raising. Used for children.

Active Trunk Movements.

The trunk movements proper take place in the joints of the lumbar and dorsal regions of the spine. Each of these joints has a very limited movement, but by combining their power of movement quite a large amount of mobility arises. On the whole, these movements, like the Neck and Head movements, take place round three axes, and we can thus divide them into Flexion and Extension round a frontal, Side-bending round a sagittal, and Rotation round a vertical axis.

On account of the structure of the small joints in the various parts of the spinal column, bending and stretching take place mostly in the lumbar region, side-bending mostly in the dorsal, and rotation chiefly in the joints between the tenth, eleventh, and twelfth dorsal vertebræ.

I. Exercises with Work chiefly for Flexors of Trunk = Abdominal Muscles.

Most of the movements under this heading take place also in the hip joints and give work to the flexors of the hip. They are also, as regards both effects and uses, similar to the "Movements for flexors of the hip," but they are classified and described here because the trunk is the part of the body which is moved. Their common effects are :—

(*a*) Exercise for flexors of hip joint and trunk.

(*b*) Increased supply of blood to the pelvic and abdominal organs (Brandt).

(*c*) Increased peristalsis, by associated action between the external abdominal muscles and the non-striated muscle fibres in the alimentary canal.

(*d*) Fixing the lower margin of the chest and thus impeding respiration.

According to the manner of working of the muscles we can divide these movements into three chief groups :—

(A) Movements in which the abdominal muscles work statically.

(B) Movements in which the abdominal muscles work eccentrically and concentrically in lengthening.

(C) Movements in which the abdominal muscles work eccentrically and concentrically in shortening.

A. Exercises with chiefly Static Work for Abdominal Muscles.

Hips-firm (or Wing)-high-ride-sitting
Neck-firm (or Neck-rest)-high-ride-sitting
Stretch-high-ride-sitting

} *Trunk - backward - drawing (and -raising).*

Wing-high-ride-sitting Trunk-backw.-drawing (Fig. 92).—The patient's knees must be fixed by a strap or by an assistant. The gymnast stands behind the patient supporting the back against his chest, or grasping the shoulders from below. The movement is performed by the gymnast drawing the patient back against his resistance, after which the patient raises himself up again to the starting position against the resistance of the gymnast. Repeated three to five times. (*N.B.*—The patient must hold the back straight the whole time so that the movement takes place only in the hip joints; the gymnast should draw the shoulders up slightly in the long direction of the trunk, and not in any way support himself against or press down the patient.)

The importance of this form of the movement is due to the fact that it can be modified to any extent, and so can be given to old or delicate patients.

NECK-FIRM-AND STR.-H.-R.-S. TRUNK-BACKW.-DRAWING.—Like the preceding, but the resistance is applied at the elbows or at the wrists. It is seldom used, and only for strong patients. (*N.B.*—Because the centre of gravity is further from the axis of movement, and because the gymnast's lever is considerably lengthened, the stretching of the trunk in the long direction must be stronger and the resistance weaker.)

FIG. 92.

Wing-h.-r.-sitting
Neck-rest-h.-r.-sitting
Str.-h.-r.-sitting
} *Trunk-backward-falling and -raising.* (Fig. 93).

The patient's knees may be fixed by a strap or in some other way. The movement is performed by the patient, carefully maintaining the position of head and trunk, falling backward in the hip joints, and then returning to the starting position. At first only a small amount of falling is made, and weak patients are supported

FIG. 93.

FIG. 94.

in the back by the gymnast. Later the support is diminished and the falling made deeper as strength increases.

The movement can of course be done in sitting position if the knees are fixed by an assistant.

Effects and Uses.—Similar to the preceding movement, but the strength cannot be so well regulated.

WING-TOE-SUPPORT-SITTING TRUNK-BACKWARD-FALLING AND -RAISING.—Like the preceding, but the feet are fixed by a wall-bar, or in some other way. The flexors of the ankle and the extensors of the knee work statically to maintain the position. The exercise is rather more severe, because the origin and insertion of Rectus Femoris are nearer each other, so that the strength of the muscle is diminished.

Wing-sit-lying
Neck-rest-sit-lying | *Trunk-raising* (*and -backward-falling*) (Fig. 94).
Stretch-sit-lying

The gymnast stands in front of the patient and fixes his knees and feet. The patient raises himself to sitting position, breathes, and returns to the starting position. Trunk quite erect. Head and shoulders must not be carried forward during the exercise.

Working muscles, effects and uses as in the preceding exercises.

(*N.B.*—Raising is harder than backward falling.)

B. EXERCISES WHERE THE ABDOMINAL MUSCLES WORK ECCENTRICALLY AND CONCENTRICALLY AND IN THE OUTER PART OF THE RANGE OF MOVEMENT (*i.e.*, "IN LENGTHENING").

Wing-loin-lean-standing
Neck-rest-loin-lean-standing | *Trunk - backward - drawing* (*and -raising*). (Fig. 95).
Stretch-loin-lean-standing

The patient stands with the sacrum supported by a boom, the gymnast behind him. Grasp and performance of the movement as in H.-R.-S. backw.-drawing, but the patient's back not supported by the gymnast.

Movement takes place chiefly in the joints of the lumbar spine.

The working muscles are :—

Abdominal muscles (eccentrically and concentrically). Flexors of the hips do not take part in the movement, but only work statically to diminish the stretching of the ligaments in front of the joint.

Effects and Uses.—Principally like the movements of the preceding group,

FIG. 95.

but because the movement is limited to the abdominal muscles, these are more exercised and the effect on peristalsis is greater. Also has repleting effect on pelvis, but this is caused by the strong arch position taken in backward-drawing.

Lastly it also increases mobility in the joints of the lumbar spine.

Wing-knee-stride-standing
Neck-rest-knee-stride-standing
Stretch-knee-stride-standing
} *Backward-drawing (and raising).*

Grasp and performance as in the preceding exercise, except that the gymnast supports the patient with one knee in the back while drawing him backward. The movement takes place first at the waist (lumbar region), then in the knee joints; in raising the knees are stretched first and then the lumbar spine is straightened out.

Working muscles, effects and uses chiefly as in the preceding exercise, except that the movement also takes place in the knee joints, the extensors of which work eccentrically and concentrically, so that the repleting effect on the pelvis is increased. Less often used.

C. Exercises where the Flexors of the Trunk (Abdominal Muscles) work eccentrically and concentrically in shortening, *i.e.*, in the Inner Part of the Range of Movement.

Wing-lax -stp.-h.-r.-sitting Trunk-backw.-drawing to vertical plane (and forward-bending).—Grasp and performance of the exercise as in h.-r.-s. backw.-drawing. Patient tries to keep the lumbar region rounded backward throughout.

Used by Major Brandt, especially in treatment of movable kidney, to strengthen and shorten the abdominal muscles.

Leg-lying Trunk-raising is usually given combined with "*Abdominal and Lumbar pressure.*"

The patient lies on his back on a plinth, trunk over one end, an over-sitter on the legs; one gymnast on each side of the patient, who places his arms over their shoulders. As the patient raises himself, with the help of the arms if necessary, the gymnasts give "Abdominal and Lumbar pressure," as already described (see Reach-grasp-st. Heel-raising and Knee-bending). Repeated three to five times.

Effects and Uses.—Specially aids peristalsis by the abdominal and lumbar pressure. Is now seldom used.

To this group also belong :—

2 (double) Knee-updrawing and -downpressing.
2 ,, Leg-updrawing and -downpressing.
2 ,, Leg-lifting and -downpressing.

These are described in connection with exercises for the flexors of the hip.

II. Exercises for Extensors of Trunk, i.e., Back Muscles.

The movements belonging to this group all give work to the extensors of the hip ; but they are classed with the trunk movements, because the trunk is the part of the body moved.

Their common effects are :—

(*a*) Exercise and development of the extensors of the hip and back.

(*b*) Diminished supply of blood in (*i.e.*, depleting from) the abdominal and pelvic organs.

(*c*) Most of them also aid respiration, through the alternate stoop and upright position of the trunk (see further Trunk-falling-forw. and -raising).

According to the muscle action they are divided into two large groups :—

(A) Exercises with *static* work for the back muscles.

(B) Exercises with chiefly *concentric* work for the back muscles.

A. Exercises with Static Work for the Back Muscles. (Back is held straight throughout.)

Here belong all movements done in Stoop-standing, Stoop-sitting, or Leg-forward-lying starting position.

Wing-fall-standing
Neck-rest-fall-standing } *Raising* (Fig. 96).
Stretch-fall-standing

Two gymnasts, standing behind the patient, lay their outer hands in front of his shoulders ; the inner ones are placed so that the hands support the back of the head and the forearms the upper part of the back. The patient now falls back to fall position, when the gymnasts raise him again while he gives slight resistance. Repeated four to six times. (*N.B.*—Patient's heels must not leave the ground while coming up.)

In Neck-rest-fall-standing Raising the outer hands of the gymnast grasp the patient's elbows.

In Stretch-fall-standing Raising they grasp the wrists.

The movement takes place in the ankle joints and the calf

muscles work eccentrically and to some extent concentrically, but it is described here because its effects are due to the work of the extensors of the neck, trunk, and hip, which keep the body in a straight line.

Used as a gentle back exercise.

Wing-standing
Neck-rest-standing } *Trunk-falling-forward and -raising.*
Stretch-standing

Free exercise. The patient lets the trunk fall forward in the hip joints as far as he can, without bending the spinal column, then raises himself and bends the back somewhat backward, so that slight "Arch position" arises. Repeated three to five times in time with breathing. Expiration while falling forward, inspiration while raising.

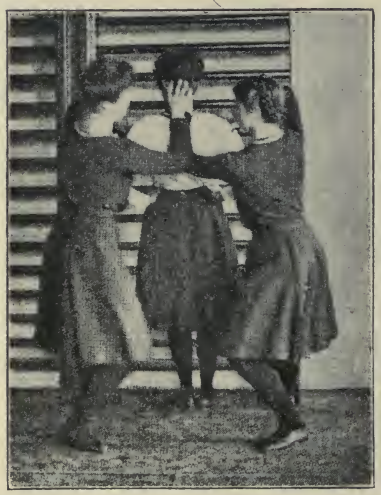

Fig. 96.

The working muscles are :—

(*a*) Extensors of the hip joint (eccentrically and concentrically).

(*b*) Extensors of the back statically, but also concentrically at the end of raising. Also the abdominal muscles work, as long as the line of gravity for the head and trunk falls behind the joints of the spine.

Effects and Uses.—Beside the effects common to all back exercises, this movement specially helps expiration as well as inspiration. Expiration is assisted because in bending forward the abdominal cavity is compressed, so that the viscera are pressed up against the diaphragm; inspiration is assisted by the strong extension of the dorsal part of the spinal column and by the enlargement of the abdomen in raising.

By the alternate lengthening and shortening of the blood vessels in the abdomen, and by the alterations of pressure (increased in forward flexion, diminished in extension), the portal circulation is also assisted.

This movement can also be combined with *Trunk-bending-forward-downward.* The back muscles then work eccentrically and concentrically, and the abdominal muscles are brought into action (concentrically) at the end of the forward bending. The effect of

the movement is then in every way stronger. *Used* mostly as a between exercise.

Wing-high-ride-sitting
Neck-rest-high-ride-sitting } *Trunk-bending-backward.*
Stretch-high-ride-sitting

Usually two gymnasts, whose position and grasp is the same as in Fall-standing Raising. The patient bends the trunk backward in the hip joint against the resistance of the gymnast, and resists when the gymnast again raises him to the starting position. May also be given by one gymnast who then places himself back to back

FIG. 97.

FIG. 98.

with the patient (Fig. 97). (*N.B.*—There must be no gliding against each other during the exercise.)

The working muscles are :—

(*a*) Extensors of the hip, especially the Glutei (concentrically and eccentrically).

(*b*) Extensors of the neck and back (statically).

Effects and Uses.—Principally as the preceding exercise, but it can be moderated at will, and is more comfortable for the patient.

Yard-stoop-stride-sitting
Yard-stoop-lean-standing } *Back-raising* (Fig. 98).

Two gymnasts, one on each side standing behind the patient, grasp his wrists with their outer hands and lay their inner hands on his back between the upper part of the shoulder blades, one hand on the other. The patient raises himself with straight back

and the arms in good yard position, while the gymnasts resist both at the wrist and in the back. The raising is finished by the gymnasts drawing the patient's arms backward, while pressing slightly in the back, so that the front of the chest is expanded. The patient then resists slightly while they push him down again to the starting position. Repeated four to six times, and concluded with the stretching described above.

The working muscles are chiefly the same as in the preceding exercise, but the back shoulder muscles must also work strongly to fix the position of the arms.

Has a strongly depleting effect on the abdominal and pelvic organs. Used especially in treatment of kyphosis combined with round shoulders.

Wing-leg-forward-lying
Wing-arch-leg-forward-lying } *Holding.*

After taking up the starting position, and after careful correction, the patient holds himself for a time in the position, then lowers the trunk and relaxes the muscles for a minute to rest, and takes the position again. Repeated two to three times.

For working muscles, effects and uses, see starting position.

(*N.B.*—Careful correction each time. First correct the position of the lumbar spine, then of the shoulders, and finally of the head.)

B. Exercises with principally concentric work for Extensors of Trunk = Back Muscles.

All these movements are performed by the patient from stoop position, first extending the hip joints so that the pelvis is raised, and afterwards the spinal column vertebra by vertebra, beginning with the lowest lumbar vertebra.

Fig. 99.

Working muscles, effects and uses are principally the same as in the preceding group of movements, but the various parts of the extensors of the back and the innervation to them are more especially exercised, as also the mobility in the joints of the spinal column.

Stoop-stride-sitting Back-raising with head support (Fig. 99).—The gymnast stands at the side of the patient and puts one hand on his neck, the other between the shoulders, and

resists, while the patient, in the same way as in the previous exercise, raises himself up, helping himself with his arms by pressing the hands against the thighs. The patient then resists slightly, while the gymnast takes him back to the starting position.

N.B.—The movement should be done in time with breathing, inspiration during and immediately after raising, and as deep as possible, expiration while bending forward. The gymnast must watch carefully that there is no deviation from the sagittal plane, or rotation of the trunk during the exercise, also that the lumbar region is not hollowed, but held as straight as possible.

Fig. 100.

It is used for weak patients and for beginners, because the movement is facilitated by the help of the arms. (*N.B.*—The neck muscles also take part in the exercise.)

Wing-stoop-stride-sitting Back-raising (Fig. 100).—The gymnast stands in front of the patient and lays his hands on the upper part of the back so that the finger-tips lie near the spinous processes just above the angle of the scapulæ. The movement is performed like the preceding, but the gymnast gives the patient a firm support in the back with the finger-tips during the deep part of inspiration following the raising and backward-carrying of the shoulders.

Fig. 101.

It is used perhaps more than any of the back-raisings because it is comfortable both for the patient and the gymnast, can be easily regulated if necessary, and does not require any special apparatus.

Wing-stoop-stride-sitting Back-raising with Stroking (Fig. 101).—Two gymnasts, one on each side of the patient, lay their outer hands in front of his shoulders ; the inner hands between the shoulders, one over the other. The movement takes place in the

same way as the preceeding, but when the patient has raised the trunk the gymnasts press back his shoulders so that an expansion of the chest is produced, while the posterior hands stroke firmly down the back.

Used especially when the chest is narrow and contracted.

Stretch-stoop-stride-sitting Back-raising.—Two gymnasts grasp at the wrists and between the shoulders. At the end of the raising a little over-stretching of the arms (upward and backward) with pressure in the back. May also be given with back-stroking.

Effects and Uses.—Like the preceding, but the movement is more tiring.

Wing-stoop-leg-lean-standing Back-raising. — Similar to Wing-stoop-stride-sitting Back-raising.

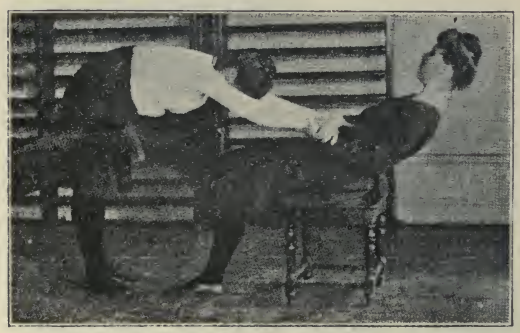

Fig. 102.

Reach-grasp-stoop-leg-lean-standing Back-raising (Fig. 102).—The gymnast sits in front of the patient. They grasp each other's hands or wrists, after which the movement is performed in the same way as the preceeding. It must be specially noticed, however, that the patient does not contract or bend the arms, and that after every raising he carries the shoulders back, making a deep inspiration.

The value of the movement is that the gymnast can give very strong resistance by pressing one foot against the boom.

Used especially for strong patients.

Reach-grasp-stoop-stride-sitting Back-raising in different planes.—The gymnast stands in front of the patient. Grasp as in the preceding exercise. Raising takes place first in the sagittal plane, then from the right-, and then from the left-turn-stoop-stride-sitting position, and finally again in the sagittal plane, two or three times in each direction. In raising from turn-stoop position the gymnast places one foot against the patient's foot to give support.

Effects and Uses.—In raising from the various turn-stoop positions the muscles on the opposite side of the back work more strongly than those on the other side. The movement therefore produces a stronger and more all round exercise for the back muscles and the joints of the spinal column than the other

back raisings. Also the different parts of the chest are more strongly compressed or expanded during the various stages of the exercise, so that a more complete ventilation of the lungs is produced.

It is used on this account especially in the treatment of patients with deformity of the trunk, such as hunchback, severe scoliosis, etc., and in after-treatment of pleurisy and other diseases of the respiratory organs.

To this group also belong all Neck-raisings. They have been described above.

Among back exercises may also be reckoned those movements and positions in which the back shoulder muscles work, *e.g.*, Plane-arm-carrying, Neck-firm position, etc. They have already been described, partly as arm exercises, partly in the "Positions derived from Standing by altering the position of the arms."

III. Movements for Side Muscles of the Trunk.

By "side muscles" are meant all the muscles going lengthwise and lying on the same side of the middle line, both at the back and front. We divide the exercises for these muscles into two large groups.

A. Movements with eccentric and concentric work in lengthening (*i.e.*, in the outer part of the range of movement) for the muscles of the side from which the flexion is made.

The common effects of the movements belonging to this group are:—

(*a*) Exercise for and development of the muscles, and increase of the mobility of the joints (also of the ribs).

(*b*) Alternate expansion and compression of the sides of the chest, so that ventilation of the lungs is assisted, and the adhesions which may exist between the lung and the chest wall, or contractions of the pleura and lung tissue, are stretched. (*N.B.*—They *cannot* be used as special exercises for scoliosis.)

Free-standing
Wing-standing
Neck-rest-standing
Half-stretch-standing
Stretch-standing
Stretch-stride-standing
} *Side-bending and -raising.*

Free movement. The patient bends the body, without any

rotation, to the side as far as possible, but tries to localise the flexion to the upper part of the spine (= dorsal region) and straightens again. Repeated alternately to both sides three to five times in time with breathing. Expiration during side-flexion, inspiration during raising. (*N.B.*—In these side-bendings the muscles also work on the side *towards* which the flexion is made concentrically, slightly at the very beginning of the exercise, until the line of gravity falls to one side of the vertebræ, and at the end of the flexion to take the movement to the very limit.)

Fig. 103.

The exercise can also be taken in *turn position*, when the flexion is made to the same side to which the body is turned. It is repeated three to five times to the same side, and then an equal number of times to the other side (after changing turn position).

In *Half-stretch-turn-standing-position* the arm of the forward turned shoulder is stretched, and the side-bending takes place to the side away from the stretched arm.

Turn position causes the action of the muscles to be varied and the mobility of the joints to be increased, but the most important effect is that the stretching of contractions and adhesions is considerably increased.

Wing-high-ride-sitting
Neck-rest-high-ride-sitting
Half-stretch-high-ride-sitting
Stretch-high-ride-sitting
} *Side-bending* (*and -raising*) (Fig. 103).

Wing-high-ride-sitting Side-bending.—Resistance exercise. The gymnast stands behind the patient and grasps him in the axilla so that the hand is close to the trunk. Supporting the patient's back with his own chest, he bends him straight to the side while the latter resists. Then the patient raises himself again to the starting position against the resistance of the gymnast.

Like the preceding exercise, it may also be done in *turn position*, and the same applies to this as was said of the last exercise.

In Neck-rest-sitting starting position the grasp is at the elbows, in Stretch-sitting at the wrists, in Half-stretch-sitting with one hand

on the wrist, the other in the other axilla. (*N.B.*—Stretching in the long axis of the body must not be omitted.)

This movement can be regulated better than the preceding, and the muscular action is limited to the muscles of the trunk, because the pelvis is so firmly fixed by the starting position.

Fig. 104.

Wing-hip-lean-walk-standing
Neck - rest - hip - lean - walk - standing
Half - stretch - hip - lean-walk-standing
Stretch - hip - lean - walk - standing.

} *Side-bending (and -raising)* (Fig. 104).

The inner leg (nearest to the support) forward. The gymnast stands behind the patient. Grasp as in preceding exercise. Flexion towards supported side. Otherwise similar to preceding exercise.

Effects and Uses.—Chiefly similar to the preceding, but because the pelvis is not so firmly fixed the hip muscles also work to fix the pelvis.

B. Movements with concentric work in shortening (*i.e.*, the inner part of the range of movement) for the muscles of the side towards which flexion takes place.

These exercises as well as the strong passive side-bendings of the trunk are used in treatment of scoliosis and are described in connection with the other special scoliosis exercises.

IV. Exercises for the Rotators of the Trunk.

If the pelvis is firmly fixed, *e.g.*, in High-ride-sitting starting position, rotations of the trunk take place, as already described, chiefly in the joints between the tenth, eleventh, and twelfth dorsal vertebræ, and are brought about by the contraction of the oblique muscles of the trunk.

In describing "Turn-standing" position these muscles are specially spoken of, and it need only be remembered here that we can class them in two groups, "Left and Right Rotators." The former on the front of the body go from below on the left obliquely upward and to the right; on the back they go from below on the right obliquely upward and to the left. The right rotators naturally go in the opposite direction.

But rotations of the trunk are also performed in starting positions

which do not at all, or only slightly, fix the pelvis, *e.g.*, Close-st., Knee-std.-st., etc., and then the movement takes place more or less also in the joints of the legs, and especially in the hip joints, so that the rotators of the hips must work. In describing " Turn-standing " position it is also mentioned more in detail how these muscles work, but it must be remembered that by the " left rotators of the pelvis " we mean the inward rotators of the left hip and the outward rotators of the right.

With the exception of the free trunk-rotations, where the muscles only work concentrically, trunk-rotations may be done in several different ways, each of which necessitates certain modifications in muscle action.

(A) The patient turns the trunk alternately to the right and left as far as possible. In this, resistance is given by the gymnast, who, standing in front of or behind the patient, places his hands one at the back and one in front of the shoulders or elbows, or grasps the wrists, according to the starting position. (*N.B.*—The rotation must be pure, without side-bending.)

Over-stretching at the end of, or more correctly immediately before, each rotation must not be forgotten, nor that the patient must take a deep inspiration between each rotation.

This form of the movement necessitates concentric work for the muscles, and the whole range of movement is traversed, *i.e.*, the muscles contract as completely as possible.

It is less used, partly because it is more uncomfortable and more difficult to give than the following, partly because respiration is impeded during the movement.

(B) The gymnast turns the patient to turn position against the resistance of the patient, who then turns back to the starting position against the resistance of the gymnast, who slightly raises the patient's shoulders. Given alternately to each side three to five times and in time with respiration. The movement is so arranged that forward-turning is done at the same time as inspiration, which then is facilitated by the lifting of the patient's shoulders spoken of above. Expiration is performed partly while the gymnast changes the grasp, partly while turning sideways.

When the movement is done in this way the muscles work eccentrically and concentrically in lengthening (*i.e.*, in the outer part of the range of movement).

It is most used of all the trunk-rotations, and is the one used, unless some other form of the exercise is indicated, because it is comfortable to give, feels pleasant to the patient, and helps rather than hinders respiration.

The forms of movement described under (A) and (B) are called "*Alternate-Trunk-turning.*"

(C) Starting from turn position the patient turns the trunk forward against the resistance of the gymnast, who then turns him back to turn position against the resistance of the patient. Repeated three to five times—first from one side, then from the other. Inspiration during forward-turning.

The muscle action is almost the same as in the preceding modification of the exercise, but it is rather more tiring because the muscles belonging to the same group of rotators are made to work continuously for three to five rotations following each other, while in the previous exercises they work alternately and so have a short rest between each contraction.

It is used in those starting positions and movements in which the gymnast cannot change his grasp easily and quickly, *e.g.*, in Wing-high-ride-fall-turn-sitting position.

When the movement is performed in the above way it is called "*Forward-turning.*"

(D) Finally, the movement may be done so that the patient performs the turning against the resistance of the gymnast, and then in his turn resists while the gymnast turns him back to the starting position.

The muscles work then concentrically and eccentrically in shortening (*i.e.*, in the inner half of the range of movement).

It is only used as one-sided hip-rotation in Heave-grasp-close-standing position to correct faulty position of the pelvis in certain scolioses.

General Effects of Trunk Rotation.

(*a*) Exercise of muscles and joints.

(*b*) Because the oblique muscles play a very important part in the performance of these exercises, they all aid peristalsis by associated movement between them and the non-striated muscles in the alimentary canal.

(*c*) By alternate lengthening and shortening of the abdominal vessels and by alternations of pressure in the abdomen, the *circulation is assisted, especially in the portal system.*

(*d*) Given in *arch position* they are *repleting to,* and in *stoop position depleting from,* the abdominal and pelvic organs. The depleting effect can be considerably increased if the gymnast resists so that the posterior shoulder muscles work especially (resistance only, or more strongly, on the shoulder or arm which is being carried back by the patient).

THE MOST USUAL STARTING POSITIONS FOR TRUNK-ROTATIONS AND THEIR EFFECTS UPON THE MOVEMENT.

Wing-
Neck-rest-
Stretch-
Yard- } *standing Alternate-Trunk-turning.*

Free movement. The patient turns himself alternately to the left and right. The muscles (rotators of the trunk and pelvis) work as described above, only concentrically. It is usually performed slowly, but may be done quickly. It is then called "*Quick Alternate-Trunk-turning*," and necessitates strong work for the muscles and stronger stretching of the ligaments and capsules of the joints. Quick turning is usually done in Stride-standing starting position. For Alternate-Trunk-turning, Close-standing or Stride-standing position may be used.

Wing-
Neck-rest- } *high-ride-sitting Alternate-Trunk-turning.*

Resistance exercise. Gymnast behind patient. The pelvis is firmly fixed by the starting position, so that the movement is confined to the trunk muscles.

FIG. 105.

WING-CLOSE-SITTING ALTERNATE-TRUNK-TURNING (Fig. 105). — The gymnast stands in front of the patient and fixes the knees firmly between his own, but avoids coming too near to the patient. Otherwise like the preceding. It is much used because it is so easily arranged.

WING-STOOP-STRIDE-SITTING ALTERNATE-TRUNK-TURNING.— Gymnast in front of patient. Stoop position must be maintained throughout. Depletes abdominal and pelvic organs (see General Effects of Trunk-rotations).

Heave-
Stretch- } *stoop-stride-sitting Alternate-Trunk-turning* (Fig. 106).

Gymnast on a stool in front of patient. Grasp round each other's wrists or forearms. Rotation must be pure. It is usually given so that the back muscles have most of the work (see above,

General Effects). It has a strongly depleting effect on the abdominal and pelvic organs. Usually " Heave position " is used.

Wing-
Neck-rest- } *knee-stride-standing Alternate-Trunk-turning.*

It is best for the patient to take the starting position on a plinth. The gymnast stands behind in step-standing position and supports the patient's sacrum with his knee. It is often given in strong arch position, when the pelvis is pushed forward and the strongest resistance is given in front of the shoulder, which the patient turns forward. (*N.B.*—The patient must not be pressed down, but instead a slight stretching must be given in the long axis of the trunk. The pelvis is not so well fixed in this position, so that the rotators of the pelvis are also brought into action. Has a repleting effect on the pelvis, especially when given in strong arch position.)

Fig. 106.

Wing-leg-forward-lying Alternate-Trunk-turning. —Gymnast in front of patient. Pelvis not fully fixed, so that the rotators of the pelvis also take part in the movement. Used in the treatment of scoliosis to increase mobility in the joints and also to exercise the back muscles.

Wing-close-standing Alternate-Trunk-turning. — Best given as Forward-turning. The side of the patient's foot is supported on the side from which forward-turning takes place by a piece of wood or by the gymnast's own foot. Hip joints as movable as possible, so that the rotators of the pelvis take a large part in the movement.

Heave-
Stretch- } *grasp-close-standing Alternate-Hip-rotation* (Fig. 107).

Gymnast in front of patient. Grasp with one hand in front of the hip at the Ant. Sup. Il. Spine, with the other hand behind the

opposite hip. The movement is usually given by method (B), but the pelvis is rotated instead of the trunk; sometimes also by (D) (see general description of Trunk-rotations).

The characteristic of this exercise, when taken in this starting position, is that the body is fixed above by grasp-standing, as well as below by its weight and the friction of the feet on the supporting area. The result is that, while the rotators of the pelvis work in the same way as in ordinary trunk-rotations, the attachments of the rotators of the trunk become reversed, so that their upper or proximal end becomes the origin. Another result is that the rotators of the trunk and pelvis, as it were, change partners, so that the right rotators of the pelvis work with the left rotators of the trunk, when the pelvis is turned to the left by the gymnast and turned forward again by the patient. This is easily understood when one remembers that the left side of the pelvis is first separated from and then approaches the lower border of the right side of the chest, and consequently the muscles going between these two points (*i.e.*, the left rotators of the trunk) are brought into action, while the right rotators of the pelvis work as in ordinary trunk-rotation.

Fig. 107.

When the movement to each side has been completed the same muscles have worked as in Wing-close-standing Alternate-Trunk-rotation, but because they have been combined in a quite different manner the innervation, *i.e.*, the work of the nervous system and its exercise, has been entirely different. The patient can use much more force and overcome much greater resistance in Alternate-Hip-rotation because the origin of the rotators of the trunk is so firmly fixed by the starting position.

Fig. 108.

It is used as a variation from trunk-rotations, and given by method (D) and to one side only, in order to correct the position of the pelvis in some forms of scoliosis.

WING-HIGH-RIDE-FALL-TURN-SITTING FORWARD-TURNING (Fig. 108).—The patient is first placed in Wing-high-ride-sitting position on a high plinth. The gymnast stands behind and with his right hand grasps the patient's right shoulder from below as in Backward-drawing; the left hand goes from above and in front under the patient's left arm and is placed, with the dorsal surface against his back, between the angles of the scapulæ. The patient's head rests against the gymnast's left shoulder. The gymnast now moves his left foot backward, lets the patient fall back till about half-way between the vertical and horizontal planes, and rotates him to the left so that he comes to be in High-ride-fall-turn-sitting position. (*N.B.*—The patient's back must be supported.) Against the resistance of the gymnast the patient turns the trunk forward, maintaining the fall position, and then resists while the gymnast turns him back to the starting position. Repeated three to five times to each side, naturally with change of grip.

Because the resistance is in front, and because of the Fall position, respiration is somewhat impeded, less so the firmer is the support in the back. It is not used, therefore, for weak patients. Is somewhat repleting to the abdominal and pelvic organs (through fall position).

FIG. 109.

HALF-WING-HALF-STR.-HIGH-RIDE-FALL-TURN-SITTING FORW.-TURNING (Fig. 109). — The patient first takes H.-r.-s. position with left arm stretched, the right arm in wing position. The gymnast, standing behind, supports him in the back with his right arm bent at the elbow, the forearm lying across the back, the hand supinated, so that at least the thumb rests in the patient's left axilla. With his left hand pronated the gymnast grasps the patient's left wrist or forearm. As in the preceding exercise, the patient is now allowed to fall back and is turned to the left, after which the movement is performed, with slight stretching of the extended arm, but otherwise like the previous exercise. (*N.B.*—Gymnast must rotate his right or left shoulder so that forward-turning is not hindered.)

By stretch position of one arm the movement is made more difficult.

Combination of Forward-turning and Raising = Plane-twisting.

Wing-high-ride-fall-turn-sitting
Half-wing-half-stretch-high-ride-fall-turn-sitting. } *Plane-twisting.*

The grasps are as in the two preceding exercises, but the movement is different, in that the patient falls lower, sometimes even to the horizontal plane, and while turning forward he also raises the trunk to the vertical position.

Effects and Uses.—Practically the same as the above, but in raising to the vertical position the flexors of the hips work concentrically and eccentrically and the straight abdominal muscles statically, so that the repleting effect to the pelvic organs, the hindrance to respiration, and the stimulus to peristalsis are all stronger.

Combination of Side-bending, Forward-turning and Raising = Arch-twisting.

Half-wing-half-stretch-high-ride-sitting Arch-twisting. (Fig. 110).—Position and grasp as in Plane-twisting in the corresponding position. Against resistance of the patient the gymnast bends him first to the side of the stretched arm, and then in an arch backwards till the trunk in Turn position comes to be in a line with the plinth. Here during a moment's pause firm stretching is made in the long axis of the trunk, after which the patient raises himself again to starting position in the same way as in Plane-twisting against the resistance of the gymnast.

Fig. 110.

Effects and Uses.—Same as Plane-twisting, but Arch-twisting is more complicated and stronger. Used only for strong patients. Formerly the movement was considered to have a special influence on the portal circulation, and has undoubtedly such an effect, though perhaps not quite so great as was supposed.

Trunk-rolling.

(See the Passive Trunk Movements.)

Passive Trunk Movements.

SIDE-BENDINGS.—See Special Scoliosis Exercises.

WING-HIGH-RIDE-SITTING SIDE-RINGING (Fig. 111).—Two gymnasts, standing behind the patient, clasp their inner hands crosswise under his shoulders, and with the outer hands grasp his arms. The movement is performed by swinging the patient's trunk alternately from side to side with a moment's pause at the extreme positions. Movement is repeated eight to twelve times to each side, and then a little pause, and a new series two to three times. The patient must be quite passive, or if this is impossible must rather help a little with the movement.

FIG. 111.

According to the older gymnasts it is good for sleeplessness.

WING - LONG - SITTING RINGING (Fig. 112). (In the sagittal plane.) Two gymnasts, standing one on each side of the patient and turned towards him, put one hand from in front under his arms and grasp each other behind his back; the other hands are laid on the patient's neck so that the forearms support the back. The movement is performed so that the patient's trunk is swung forward and backward (not quite to horizontal plane) in rather quick time.

FIG. 112.

Acts as the above, but is said to be stronger. It is certain that this movement is more uncomfortable to take.

WING-HIGH-RIDE-SITTING CIRCLE-TURNING.—The position and grasp of the gymnast is similar to Wing-high-ride-fall-turn-sitting Forward-turning, but the patient does not fall backward. The movement is performed by the gymnast carrying the patient's trunk round in small circles, to the side (left), backward and forward, so that side flexion and rotation are combined. Repeated eight to twelve times, and, after change of grasp, as many times to the other side.

The movement is somewhat modified according to the desired effect.

If it is desired *to aid respiration*, it is given in somewhat larger circles and in time with breathing—inspiration during the first part of the rotation, expiration during the latter part and afterwards.

If the object is chiefly *to assist circulation*, the circles are smaller and speed increased. Respiration then easily becomes impeded.

N.B.—The gymnast must carefully notice that he does not support himself on the patient and thus press him down, but instead he must make a slight stretching in the long axis of the trunk. The grasp must not be so firm as to fix the chest. When the movement is given to heart patients care must be taken that respiration is not impeded.

The movement must be given so that it takes place chiefly in the joints of the spinal column (not in hip joints).

Effects and Uses.—(*a*) Loosens the joints. Used on this account sometimes in scoliosis treatment.

(*b*) Aids respiration, especially inspiration. Because the expansion of the chest is not very great and does not affect both sides of the chest at the same time, the movement is used with advantage for weak patients, and particularly for heart patients.

(*c*) Aids circulation, especially portal circulation, partly because respiration is aided, partly through alternations between increased and diminished pressure in the abdomen, partly through alternate lengthening and contraction of the blood vessels of the abdomen.

Wing-stride-standing
Wing-loin-lean-stride-standing
Wing-high-ride-sitting
Spring-sitting
} *Trunk-rolling.*

Trunk-rolling can be done actively as well as passively, but as the passive form is most used in medical gymnastics the movement is described here together with the other passive trunk exercises.

It is performed by the trunk being carried, in as large circles as the mobility allows (forward, to the left, backward, to the right, and forward again), eight to twelve times in each direction. Inspiration during the backward part, expiration during the forward part, of the circle of movement.

Effects and Uses.—(*a*) Mobility of the joints is increased.

(*b*) Respiration is aided.

(*c*) Portal circulation is aided.

(All in practically the same way as in circle-turning, though more strongly.)

(*d*) By the strongly increased pressure in the abdomen in forward and side bendings a mechanical stimulation is produced on the whole alimentary canal, so that the activity of the cells, secretion of the digestive juices, and peristalsis are strongly stimulated.

(*e*) When the movement is done actively there is also exercise of the muscles round the trunk, going between the pelvis and the thorax, and a stronger effect upon digestion and peristalsis. On this account the movement has an extensive use in general gymnastic treatment, and in the treatment of diseases both of the digestive and respiratory organs. For heart patients, on the contrary, it is often too strong.

WING-STRIDE-STANDING AND WING-LOIN-LEAN-STRIDE-STANDING TRUNK-ROLLING.—In these positions it is most often done actively.

FIG. 113 *a*.

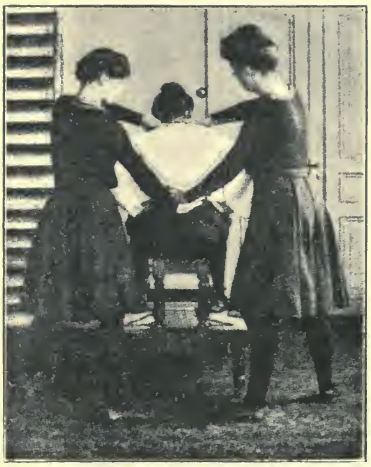

FIG. 113 *b*.

It takes place both in the hip joints and in the joints of the spine : most of the muscles going between the thigh and the pelvis and between the pelvis and the trunk are brought into action.

Used especially for home gymnastics.

WING-HIGH-RIDE-SITTING TRUNK-ROLLING (Fig. 113, *a* and *b*).—Here the movement is usually passive, and the patient is best fixed by a strap across the legs (near the pelvis). The gymnast stands behind the patient and lays one hand on his shoulder (close to the neck), the other on the sacrum if he is working alone.

If two gymnasts are obtainable the movement is considerably easier. They grasp with their outer hands the patient's shoulders ; the inner hands are laid on the sacrum so that the pelvis can be supported both at the sides and behind. The movement is per-

formed as described above, but ought to take place chiefly in the joints of the spine and as little as possible in the hip joints. (*N. B.*—When the patient is bent forward the pressure on the sacrum is lessened so that the pelvis can move slightly backward.)

If the patient has difficulty in being quite passive he may help a little with the movement.

Spring-sitting Trunk-rolling.—Used for treatment of scoliosis (see the Special Scoliosis Exercises).

Wing-stoop-stride-sitting
Wing-high-ride-sitting
Wing-arch-low-knee-stride-standing
Wing-arch-high-knee-stride-standing
} *Screw-twisting.*

This movement is always passive. It is performed by the patient's trunk being turned from one side to the other, first slowly and a little way, then more quickly and with larger excursions, which decrease again, at the same time diminishing in speed. The movement is repeated with short pauses two to three times, with ten to fifteen rotations in each series.

Effects and Uses.—(*a*) Loosens the joints.

(*b*) Produces a mechanical stimulation of the walls of the alimentary canal, so that the activity of the cells and the secretion of digestive juices and peristalsis are increased.

(*c*) The lungs are also affected by the shaking, so that the activity of the cells and the interchange of gases between the tidal air and the residual air are increased. The movement helps the loosening and expectoration of mucus and stretches any adhesions present between the lung and chest wall.

(*d*) If the movement is given in strong arch position it repletes strongly the abdominal and pelvic organs (Brandt).

Wing-stoop-stride-sitting Screw-twisting.—Two gymnasts, standing behind the patient, lay their outer hands in front of his shoulders, the inner hands between his shoulder-blades and on each other.

The movement is performed as described above. Care is taken that the patient maintains stoop position throughout.

In this form the exercise works most strongly upon the abdominal organs; also stoop position depletes them.

Wing-high-ride-sitting Screw-twisting.—Grasp as in the preceding. Acts chiefly on the thoracic organs.

Wing-arch-low-knee-stride-st. Screw-twisting.—The gymnast stands in walk-st. position behind the patient, the front foot pushed well forward between the patient's knees. Grasp at the

axilla either from below or in front. The patient is first drawn somewhat forward and then bent backward over the gymnast's knee, which supports him at the sacrum, so that strong arch position arises, after which the movement is given.

N.B.—Stretch in the long axis of the trunk.

Fig. 114.

Wing - arch - high - knee - std. - st. Screw - twisting (Fig. 114). — Patient kneels on a plinth. Gymnast stands behind in step-standing position and grasps the axillæ from below. Otherwise like the preceding.

Both the last forms of the exercise are strongly repleting to the pelvis, and must be given with the greatest care, at any rate for the first few times.

Sitting (*or really Lax-sitting*) } *Chest-*
High-ride-sitting } *lifting.*

Sitting Chest-lifting (Fig. 115).—The gymnast stands behind the patient, supporting him in the back with his own hip or thigh. Often a little cushion is placed behind the patient's back. Grasp under the axilla from in front or behind, and close to the body. The patient's shoulders are lifted so high that the ribs are also raised and a deep inspiration is caused, after which the shoulders are carried slightly back with firm pressure in the back so that the front of the chest is expanded; finally they are lowered again, and at the same time the pressure in the back is relaxed, so that the patient completely relaxes the trunk and breathes out strongly. These three movements ought to blend imperceptibly with each other. Movement is repeated six to ten times, with a short pause after each expiration. (*N.B.*—Pressure in the back must be steady enough for the patient not to be drawn back at the hip joints when the shoulders are drawn back.)

Fig. 115.

When the movement is done in H.-r.-s. position (Fig. 116) the gymnast supports the patient's back with his chest. The axillæ are grasped from behind.

In this way the movement is often used after a strong active trunk movement. Given three to five times.

Fig. 116.

Chest-lifting in different planes is the same movement given in the above positions, as well as in turn position to the right and to the left.

The movement takes place in the sterno-clavicular joints and in the joints of the spinal column and ribs.

Effects and Uses.—(*a*) Particularly good respiratory exercise, which can be easily modified. For the effect of respiratory exercises, see Standing 2 (double) Arm-carrying-forward-upward-outward-downward.

(*b*) Stretches soft parts on front of the chest.

Used very much in medical gymnastics, both in general gymnastic treatment and in treatment of heart disease and diseases of the respiratory organs, and in treatment of weak and contracted chest.

Chest-lifting in different planes has a more general effect both on the mobility of the joints and the ventilation of the lungs, and is used especially for patients with deformed thorax.

Fig. 117.

Half-lying Chest-lift-stroking (Fig. 117).—The gymnast stands in front of the patient and puts his hands behind the back at the height of the shoulder-blades. While the patient breathes in, the gymnast lifts the chest upward and forward, not high enough to lift the head from the support, and strokes with the hands down the back and forward over the sides of the chest, finishing with slight pressure over the lowest ribs in front, while the patient breathes out. Repeated six to ten times. (*N.B.*—When the movement is given to heart patients the pressure in front of the chest is omitted. When given to emphysematous patients, on the contrary, a firm pressure is made on both sides and in front to assist expiration.)

Effects and Uses.—Chiefly the same as the preceding, but Chest-

lift-stroking is a more gentle exercise for inspiration, while expiration can be greatly assisted by the pressure. It is used much, chiefly for weak patients in bed and for heart patients, and as a special movement in treatment of emphysema.

Neck-rest-standing
Heave-sitting
Heave-grasp-standing
Stretch-grasp-standing
} *Chest-expansion.*

Chest-expansion is produced either by carrying the patient's arms backward, or backward and upward, while the trunk is fixed by support in the back, or by pressing the trunk forward by pressure in the back while the arms are fixed (generally in Heave-grasp or Stretch-grasp position).

It is common to all Chest-expansions that they produce a stretching of the soft parts in front of the chest. If the movement is given gently and in time with breathing, it acts as a gentle exercise for inspiration, because the ribs are raised and the chest expanded. If given more strongly, its most marked effects are a strong stretching of the soft parts in front of the chest and correction of the position of the shoulders. Chest-expansions are used also partly as respiratory exercises at the beginning and end of a table, partly in treatment of kyphosis, flat chest, etc.

Neck-rest-standing Chest-expansion.—The gymnast supports the patient's back with his own chest and grasps the elbows from below.

Heave-sitting Chest-expansion.—The gymnast stands on a stool behind the patient, supporting the back with his own knee (often a little cushion between). The patient's arms are in heave position with palms turned forward. They grasp each other's elbows; the gymnast then gives a fairly strong and continuous, though not sudden, stretching, which is repeated four to six times with small pauses for respiration. Used for weak patients with contracted chest or kyphosis.

If the movement is to be given as a respiratory exercise the patient may preferably take H.-r.-s. position (with arms slightly outward, forearms slightly forward, and hanging loosely down). The gymnast stands behind and grasps the patient's arms from below and carries them backward and slightly upward, while he supports the patient with his own chest. After a short expansion the arms are lowered again to the starting position. Given in time with breathing five to eight times.

Heave-grasp-standing and Stretch-grasp-standing Chest-expansion (Fig. 118).—The gymnast stands behind the patient in walk position, or, if the expansion is to be strong, in fall-out position, and places one hand between the shoulders, while with the other he holds a strap going round the patient's hips to fix the pelvis. The expansion is made by the gymnast first pressing the patient forward as far as possible, and then by small pressures taking the expansion to the extreme limit. Movement is repeated three to five times with short pauses for respiration.

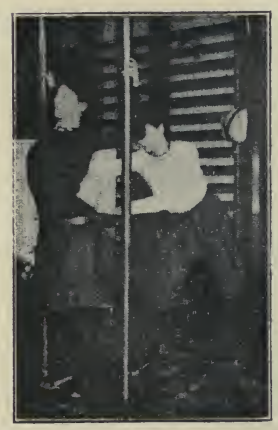

Fig. 118.

When the movement is given as a respiratory exercise the strap is not used round the hips, but the gymnast controls the movement with one hand on the patient's abdomen so that it is not pushed too far forward, while with the other he gives the movement. After the expansion of the chest the patient draws himself back against slight resistance of the gymnast. In this way the movement causes slight exercise for the muscles of expiration. Repeated six to eight times.

Stretch-grasp-standing Forward-drawing (Fig. 119).—Best given at the wall-bar or peg-post. The gymnast stands in front of the patient, taking leverage with one foot against the apparatus. Grasp and movement as in Half-lying Chest-lift-stroking, but the expansion at the beginning of the movement is made more strongly, and the patient draws his own trunk back while breathing out, as in the preceding exercise. Repeated six to eight times.

Fig. 119.

Effects and Uses.—The movement assists both inspiration and expiration strongly, and is used, therefore, in the same way as other respiratory exercises, and as a special movement in the treatment of emphysema, in which, however, Heave-grasp-standing position is to be preferred, because it allows more complete expiration than Stretch-grasp-standing.

Special Massage Manipulations.

The massage manipulations found among the so-called passive movements of the old gymnasts were different forms of Hacking, Clapping, Beating, Shaking, Kneading, Stroking, Nerve Pressures; recently also Nerve Frictions and Abdominal Kneading or Abdominal Treatment, in which several of the above manipulations are included.

All these may without difficulty be classified under the four well-known groups of massage movements: Effleurage, Pétrissage, Frictions, and Tapôtement.

Hacking, clapping, beating, and shaking are thus only different forms of tapôtement. Kneadings are done partly as pétrissage, partly as a kind of large frictions. Strokings are generally done in a centrifugal direction, less often as effleurage, *i.e.*, centripetal stroking. Nerve pressures and nerve frictions are really only modifications of tapôtement or friction applied to nerves.

The technique for all these manipulations, however, is somewhat different, according to the various places where they are applied, so that the most important are here shortly named and described.

Hacking.

Hacking can be done in many ways, and each gymnast develops usually a special way for himself.

A very good way is that the gymnast, with the arms bent at the elbows, hands bent back at the wrists and fingers spread out wide, performs hacking chiefly by pronation and supination combined with small flexions and extensions of the elbow. After some practice hacking can in this way be given continuously and, according to the requirements, with greater or less force.

By spreading the fingers each stroke becomes elastic and also made up of three to four small strokes, as the fingers do not all at once meet the part worked upon, but follow one after the other. If hacking is to be given more strongly, one may bend the fingers slightly and let them all together strike the part with their dorsal surfaces, or in specially strong hacking it may be done with the ulnar border of the hand. In very strong hacking the wrist and elbows also take part in the movement.

The general effects of hacking are naturally included in the effects of tapôtement, but may here be briefly recapitulated :—

(*a*) Light hacking causes a mechanical stimulation and consequently increased activity of the cells of the tissues worked upon.

(*b*) Hard hacking assists the dissolution of the products of inflammation, partly by mechanically breaking them up, partly by increased hyperæmia (see below).

(*c*) Applied to nerves, hacking causes a stimulation which is carried both centrifugally and centripetally, by which the conducting paths and their central and peripheral endings are set in action; consequently also the muscles. This again causes, according to physiological laws, increased supply of blood and increased nutrition to the parts set in action. The change in the condition of a nerve, so often spoken of, causing neuralgic pain to cease, which is said to be brought about by tapôtement of the nerve trunk, is no doubt often connected with the dissolution of products of inflammation in the nerve and its surroundings.

(*d*) On vaso-motor nerves light short hacking produces stimulation, causing contraction of the blood vessels. A stronger and more continuous hacking produces, on the contrary, expansion of the vessels (by paresis of the constrictors). This is made use of to produce hyperæmia and thus make torpid inflammatory processes more acute.

Hacking has a very wide use in mechano-therapeutics, and can be given on almost all accessible organs and tissues. A few special forms will be spoken of in more detail.

Sitting Head-hacking, or Head-treatment.—This comprises several different kinds of hacking, viz. :—

1. *Ordinary light hacking*, beginning in front and going backward over the whole head.

2. So-called *point hacking*, performed more slowly and strongly so that all the finger-tips of one hand meet the head at the same time.

3. "*Combing*," in which the tips of the fingers, pressing against the scalp, are quickly carried through the hair; the fingers should be crooked so that the dorsal surface comes in contact with the scalp.

4. "*Brushing*" is performed by the palmar surface of the fingers or hands quickly and lightly gliding over the head.

5. "*Piano-playing*" is hacking given with the tips of the fingers, which, as in piano-playing, run lightly over the head.

6. "*Light stroking*" begins at the crown of the head and continues over the side, neck, and arms down to the hands.

Effects and Uses.—(*a*) Helps to break up inflammatory products in the scalp, and thus relieves headaches of rheumatic origin.

(*b*) Possibly produces a slight contraction of the blood vessels in the membranes of the brain and its outermost layers, through

which the feeling of weight, due to congestion in the head, is relieved. When this effect is required the treatment must not continue too long.

Reach-grasp-standing } *Back-hacking*
Reach-grasp-sitting } (Fig. 120).

Fig. 120.

Given rather strongly, either *lengthwise*, with one hand on either side of the spinous processes, or *diverging*, more or less transversely. Repeated three to five times.

Effects and Uses.—Longitudinal Back-hacking produces stimulation of the posterior branches of the spinal nerves, which is then carried to the spinal cord and its nerve cells. Here various reflexes arise, and, since the reflex apparatus in nearly the whole length of the cord is brought into action, these extend over the whole body and increase vitality generally. It is used on this account in the treatment of many diseases of the spinal cord, such as tabes, etc., in neurasthenia and debility of the nervous system, and in general weakness. Even the activity of the heart is affected reflexly, so that it becomes stronger, and above all quicter.

Fig. 121.

Divergent Back-hacking is used in treating the back muscles, especially to break up products of inflammation in them.

Stretch-grasp-side-arch-standing Side-hacking and -clapping.—Given strongly, but only over the lung. Stretches adhesions between the lung and the chest wall.

Heart-hacking, or, more correctly, Local Heart-treatment (Fig. 121).—The patient is best placed in lying or half-lying starting position. The gymnast stands or sits at his side. The treatment consists of several different manipulations :—

(1) *Soothing stroking* over region of heart; (2) *Light gentle*

Hacking; (3) *Stroking;* (4) "*Tapôtement à l'air comprimé,*" in which the cupped and relaxed hand is carried over the heart region and is extended so that the palmar surface becomes convex, the convexity touching the chest wall in passing with a light elastic tap; the rate of movement must correspond with the desired heart-rate; (5) *Stroking;* (6) *Vibrations.* This series is repeated usually twice; the whole lasts three to five minutes.

Effects and Uses.—HACKING produces probably a mechanical stimulation of the heart muscle and its ganglia, whereby the contractions become stronger and less frequent.

TAPÔTEMENT À L'AIR COMPRIMÉ produces a rhythmical stimulation of the heart, which then attempts to make its rate coincide with the stimulus.

STROKING has a soothing effect.

VIBRATIONS in general soothe the heart's action, but not always. Experience shows that different people react differently to them.

Local heart treatment *is used* in the treatment of heart diseases, but irritates some patients, to whom naturally it is not given. It is very possible that suggestion often plays a greater or lesser part in the effect of the treatment.

Clapping.

Usually done with the palmar surface of the hand. The wrist must not be held stiff, but must be quite relaxed.

Effects in general similar to hacking, but it is used especially when one wishes to produce stimulation of the skin, *e.g.*, in diminished sensation, or to cause an increased production of heat. For cold feet *Foot-clapping with rod* is used.

FIG. 122.

Chest-clapping merits a special description.

HEAVE-GRASP-STANDING CHEST-CLAPPING (Fig. 122).—The gymnast stands in front of the patient and begins the clapping on the back of the chest over the upper parts of the lungs, continues from there down the back and forward over the sides, then to the front of the chest, where hacking is given along the lower ribs, and up the sternum to the upper part, when clapping is again given. From there clapping is continued on the sides of the chest close under the axillæ and round again to the back, after which the whole is repeated three to four times.

Clapping is given rather strongly over the back and upper parts of the sides; but on the lower parts of the sides and in front it is done lightly, otherwise it feels uncomfortable. In hacking along the lower ribs in front, hacking over the pit of the stomach must be carefully avoided. Finished by giving Forward-drawing a few times.

Chest-clapping is often combined with Walk-st. 2 (double) Arm-carrying-outw.-upw.-outw.-downw.

Effects and Uses.—If chest-clapping is given correctly it produces a gentle shaking through the chest cavity, so that :—

(*a*) Vitality of the lung tissue and cells of the bronchial tubes is increased, and consequently their power of resistance to disease.

(*b*) Interchange of gases between the tidal air and the residual air is facilitated, and thus the output of CO_2 and the intake of oxygen is increased.

(*c*) Loosening and expectoration of mucus is assisted. For these reasons chest-clapping is very much used, both in treatment of lung and heart diseases and in treatment of general weakness.

Fig. 123.

Beating

is performed with loosely-closed hand and loose wrist. In general it is used when a particularly strong tapôtement is indicated, as, *e.g.*, to break up the products of inflammation or to produce an active hyperæmia.

The following have a special effect :—

Arm-lean-stride-standing
Arm-lean-stp.-std.-standing — *Sacral-beating* (Fig. 123).
Arm-lean-stp.-std.-sitting

In the first two positions the patient usually turns the heels slightly out. The gymnast stands at the side of the patient and with one hand supports the patient's abdomen just above the symphysis pubis, with the other hand gives beating in small series (five to seven strokes), going from the middle line obliquely outward and downward over the sacrum and gluteal region, on each side alternately.

Effects and Uses.—According to the force with which beating is

given and the starting position, the effects are various. If given strongly and in Arm-lean-stride-standing position, it strongly repletes the abdominal and pelvic organs (Brandt) and relieves constipation, the latter according to old gymnastic tradition. Given lightly and in Arm-lean-stoop-stride-standing or -sitting position, it stimulates the organs of the true pelvis and nerves supplying them, partly by reflex action and partly by the shaking of the whole pelvis, while stoop position counteracts too great a supply of blood to the pelvis (Brandt).

Used in treatment of debilitated conditions of the abdominal and pelvic organs and in constipation.

Shaking and Vibration.

These, both in character and effect, closely resemble tapôtement. They consequently stimulate the parts worked upon—*i.e.*, increase the activity of the cells, and assist the dissolution and absorption of the products of inflammation. They are specially used in cases where great sensitiveness or tenderness does not allow any stronger treatment.

On account of their power of acting even upon the deep-lying parts and on organs which by means of a more or less complete bony covering are prevented from being influenced in any other way, they are of great use in treating changes in the abdominal or thoracic organs, and in diseases of the brain and spinal cord. The effect of vibrations on the peripheral nerves is spoken of in connection with nerve pressures and nerve frictions. Applied to mucous membranes they assist in the manner above described in loosening and carrying away the mucus, and possibly also diminish congestion (by their effect upon the blood vessels and their nerves). On this account they are much used in treating various catarrhs.

Fig. 124.

Crook-half-lying Stomach-pit-shaking (Fig. 124). — The gymnast stands in front of the patient with the palmar surfaces of the hands and the fingers close together. The finger-tips are placed in the pit of the patient's stomach (half-way between the umbilicus and the ensiform process), and, when the patient

breathes out, are pressed inward and slightly upward while continuous shaking is performed. Repeated three to four times. If the patient has a tendency to contract the abdominal wall the shaking is introduced by a gentle kneading of the pit of the stomach.

Effects and Uses.—The shaking comes in contact with the pyloric end of the stomach and has the above-mentioned effects there. But if given sufficiently strongly it may exercise a stimulation on the cœliac plexus and the nerves going from it. The results of such stimulation are not very well known, and may consist of either an inhibitory or a stimulating effect on the activity of the organs influenced by these nerves, but it is supposed that the stimulating effect predominates. On this account Stomach-pit-shaking is used, in the treatment of chronic gastritis and dyspepsia, etc., in atony and other relaxed conditions, and in nervous diseases of the stomach.

The same contra-indications obtain as for abdominal massage (acute inflammation in the alimentary canal and peritoneum, gastric ulcers, malignant tumours, etc.).

Crook-half-lying Stomach-shaking.—One or both of the gymnast's hands are placed on the patient's abdomen so that the finger-tips lie about 5 cm. below the left lower costal margin. As the patient breathes out the fingers are pressed inward and upward while shaking is performed, so that the pressure is directed upward toward the stomach. Repeated, with small pauses for breathing, four to eight times.

Effects and Uses.—This shaking comes in contact with the stomach over a larger area than the preceding, and is therefore more effectual both as regards increasing peristaltic action and promoting the secretion of gastric juice. On the other hand, the cœliac plexus is not affected.

Details with regard to the above effects have been already given by Dr. Kleen in connection with abdominal massage and its use, but I will briefly recall them.

By stimulation of the non-striated muscle fibres peristaltic action in the stomach is increased, so that the gastric juice is better mixed with the contents and digestion aided, as well as the emptying of the stomach hastened. Moreover, the muscle after some time becomes, as it were, "trained," so that it is developed and becomes stronger, and thus disturbances of function in connection with weak stomach muscle in certain cases, as in early atony, may be definitely cured, and in any case much improved.

By stimulation of the glands of the mucous membrane it is possible that a more active secretion of gastric juice may be caused.

It has already been pointed out that mucus is loosened and absorption of the products of inflammation is aided.

It is used nearly always in the gymnastic treatment of gastric complaints.

CROOK-HALF-LYING TRANSVERSE-ABDOMINAL-SHAKING.—The gymnast places one hand on the patient's abdomen and performs shaking from side to side, first lightly and with small movements, then more strongly and with larger movements, finally more gently again and with smaller movements, while the pressure of the hand similarly is first increased and then diminished. Repeated three to four times.

Transverse-abdominal-shaking acts upon the intestinal canal in a similar way to Stomach-shaking on the stomach, and is used in treatment of chronic intestinal catarrh and in atony and other conditions of slackness in the intestines.

FIG. 125.

It may also have a *stretching effect on adhesions* between the intestines themselves, or between them and the abdominal wall.

If the shaking is extremely fine and light, it has in many cases been proved effective in stopping diarrhœa, or at least diminishing it.

CROOK-HALF-LYING LUMBAR-SIDE-SHAKING. — The gymnast places the hands immediately over the patient's iliac crests and performs shaking by alternately and quickly carrying the hands backward and forward, giving pressure inward and downward.

It has the same effect as, and is used similarly to, the preceding exercise, but works specially upon the ascending and descending colon.

Crook-half-lying } *Bladder-shaking* (Fig. 125).
Lax-sitting }

Usually Bladder-shaking is introduced by a light and gentle kneading over the region of the bladder. After that the gymnast places himself in front of the patient and lays his hands, pronated and side by side, about 5 cm. above the symphysis. It may be done over one layer of clothing. While the patient makes a slow expiration the hands are pressed downward against the bladder, so

that the fingers lie parallel to the posterior surface of the symphysis, and shaking is done in the form of small movements directed towards the bladder. Given several times with short pauses. If the patient feels a slight desire to pass water the shaking is given correctly. (*N.B.*—The bladder ought to be emptied immediately before the treatment.)

Effects and Uses.—Bladder-shaking works upon the bladder as Stomach-shaking on the stomach :—

(*a*) The non-striated muscle fibres are stimulated to contraction, and so exercised and strengthened.

(*b*) Activity of the cells of the mucous membrane is increased, and consequently also their power of resistance.

(*c*) Absorption of the products of inflammation is promoted.

(*d*) Mucus is loosened and carried away.

It is used chiefly in the treatment of atony and paresis and other slack conditions in the bladder, and also for nervous disturbances of the bladder.

Contra-indications are : all infective cystitis, tumours, stone or other foreign body, and tuberculosis in the bladder.

Crook-half-lying Perineum-shaking.—The gymnast places his hands, with palmar surfaces closely against one another, so that the finger-tips press against the perineum, and directs a tolerably strong shaking upward against the lower part of the bladder, or backward against the rectum, according to the desired effect. It acts as the other shakings, and is used :—

(*a*) With the same indications as Bladder-shaking.

(*b*) In treatment of hæmorrhoids.

(*c*) In various relaxed conditions in the organs of the true pelvis.

Reach-grasp-sitting
Reach-grasp-standing
Heave-grasp-standing } *Back-tremble-shaking or -vibration.*

The gymnast lays his hands with the fingers slightly bent so that their dorsal surfaces lie against the patient's back one on each side of the spinal column between the shoulder-blades, and gives in this way a gentle but continuous tremble-shaking. Repeated several times. May also be given with a vibrator, when the vibrations are usually given along the whole spine.

Effects and Uses.—Chiefly similar to Back-hacking. Vibrations down the back are specially used to calm the heart's action, and in treatment of diseases of the spinal cord and in neurasthenia to exercise a stimulating effect upon the nerve elements of the spinal cord.

Back-support-standing
Heave-grasp-standing } *Side Chest-shaking.*

The gymnast places his hands at the sides of the patient's chest, over the lower ribs, and performs a shaking, at the same time compressing the chest while the patient breathes out. During inspiration the pressure is removed. Repeated six to eight times.

Effects and Uses.—Expiration is helped by the pressure, while the shaking has the same effect as Chest-clapping. The interchange of gases between the tidal and stationary air is promoted.

Used specially in treatment of emphysema.

Half-lying Chest-lift-shaking.—Performed like Chest-lift-stroking, with the addition of an even shaking at the same time as the stroking. Repeated five to six times and finished with a few simple Chest-lift-strokings.

Effects and Uses.—Assists both inspiration and expiration and the interchange of gases. At the same time it is specially pleasant and effective, and can be regulated according to desire.

Used, therefore, with good effect in the treatment of general weakness and in heart and lung complaints.

Sitting Throat- and Larynx-shaking.—Introduced usually with a gentle kneading of the neck over the sides of the throat and larynx. The shaking of the throat is directed upward, inward and backward; larynx-shaking from side to side. The gymnast may either stand behind the patient, support the head with his chest, and work with the hands on each side of the neck, or stand at the side of the patient, supporting the head at the occiput with one hand, while the other grasps the front of the neck and performs shaking.

Effects and Uses.—The mucous membrane of the pharynx and larynx is acted upon in a similar manner to the other membranes already mentioned treated by shaking. It is used in treatment of chronic pharyngitis and laryngitis and in lack of tone or relaxed conditions of the muscles of the throat and larynx.

Sitting Nose-root-shaking.—The gymnast grasps the patient's occiput with one hand, while the other grasps the root of the nose and performs a shaking as forcibly as necessary to affect the chronic catarrh in the mucous membrane of the nose. Sometimes combined with Wing-stoop-stride-sitting Back-raising.

Crook-half-lying Under-kidney-tremble-shaking.—Given to one kidney at a time. The gymnast places both hands close together and side by side against the front of the patient's abdomen about 6 cm. below the costal margin. Patient is told to make a quiet expiration, and at the same time the abdominal wall is

pressed in as deeply as possible, while a shaking is made, directed obliquely upward and backward. If the kidney has sunk it is first replaced, by the hands being pressed in below the kidney, perpendicular to the posterior abdominal wall, and then slowly and carefully carried upward and backward.

Effects and Uses.—(*a*) Stimulating to the tissues in the neighbourhood of the kidney, so that its maintenance in position is more likely (Brandt).

(*b*) After reduction the ureter is straightened out, so that urine obtains a free passage and distension of the pelvis of the kidney ceases and the patient is greatly relieved. One ought, therefore, to teach the patient himself to replace the kidney.

(*c*) With the idea that mechanical stimulation of the activity of the kidney is possible, this manipulation has been used in treatment of chronic inflammation of the kidney.

Kneading

may be given in two ways ; either the tissues worked upon, usually the muscles or skin, are lifted from the underlying surface and squeezed between the thumb and fingers (pétrissage), or the tissues are pressed against the underlying surface by circular kneadings, or between both the gymnast's hands moving in as large circles as possible without gliding over the skin (frictions). If the kneading is given more superficially and gently it is called " rolling."

In medical gymnastics the kneadings used are :—*Arm-* and *Leg-kneading*, *kneading of isolated muscles or groups of muscles*, *Skin-kneading*, and *Abdominal-kneading* (or, more correctly, *Abdominal-treatment*, because it usually consists of several manipulations).

As for all manipulations, the tissues worked upon should be entirely passive and as relaxed as possible.

The *general effects of kneading* combine those of pétrissage and friction. They are :—

(*a*) Mechanical stimulation of the tissues worked upon, so that the activity of the cells is increased.

(*b*) Breaking-up of products of inflammation.

(*c*) By the alternation of pressure, Arm- and Leg-kneading specially assist the venous circulation.

Kneadings have always been a favourite manipulation of Swedish gymnasts, and are much appreciated by patients. They are specially used :—

(*a*) In treatment of muscle atrophy and other conditions of loss of tone in the muscles.

(*b*) In muscular inflammation.

(*c*) In general weakness, because they increase general metabolism and the formation of heat in the body. They are then given over a large area (arms, legs, back, and abdomen).

(*d*) In treatment of heart patients, on account of their good influence on the circulation.

(*e*) In diabetes, because they increase the vitality of the muscles, and consequently the body's power of oxidising carbohydrates.

(*f*) Finally, in the treatment of obesity, vigorous kneading of fat masses in the skin promotes their absorption.

Sitting or Half-lying Arm-kneading.—The gymnast stands at the side of the patient in step-standing position, with the patient's arm over his knee. First the shoulder muscles are kneaded thoroughly with one hand, the other steadying the front of the trunk; afterwards the arm from the shoulder down to the hand, for which both hands are used. Repeated two to three times. (*N.B.*—The gymnast performs the kneading most easily if he stands behind the arm when treating the right arm, and in front of the arm when treating the left.)

Half-lying Leg-kneading.—The gymnast sits in front and at the side of the patient in stride position, and places one of the patient's legs over his inner leg. Kneading is given first over the hip muscles with one hand and then continued with both hands down over the whole leg, at the sides, back and front. The calf is kneaded most easily if the knee is bent and the foot supported against the gymnast's leg.

Crook-half-lying Abdominal-kneading, or Abdominal-treatment.—Abdominal massage consists chiefly of two manipulations, first, *large kneadings of the whole abdomen*, second, *colon frictions.*

Kneading may naturally be done in many ways. For example, the gymnast, sitting at the patient's side, places one hand, or one on the top of the other, on the patient's abdomen, and kneads first with large movements from side to side, then with more circular movements going from right to left, so that the heel of the hand, the ulnar and radial sides, and the fingers come into contact with the abdominal wall in turn—never the whole hand at once, as this would impede respiration too much. Another method, described by Dr. Wide, is that "the gymnast places himself in front of the patient and lays his hands one on each side of the patient's abdomen and then performs kneading with both hands, making circular movements so that one hand goes forward and the other backward."

Colon frictions are most suitably performed in the manner already described by Dr. Kleen, *i.e.*, the gymnast, holding his

fingers extended, brings the palmar surfaces of the middle three fingers closely adducted over the part which is to be massaged, with moderate force presses through the abdominal wall, and with small circular manipulations and even pressure, as it were kneads or presses the corresponding part of the alimentary canal between the anterior and posterior walls of the abdomen, while the patient's skin follows the masseur's fingers in their excursions, and no lubricant is necessary. In this way the colon is treated, beginning at the cæcum and going over the ascending, transverse and descending colon, and the sigmoid flexure as far as the symphysis pubis, carefully working each square centimetre of the intestine, except those parts (hepatic and splenic flexures) which for anatomical reasons are out of reach. Abdominal-kneading is often combined with Stomach-pit-, Stomach-, Transverse-abdominal-, and Lumbar-side-shaking, also with Transverse-abdominal-, Colon-, or Lumbar-side-stroking. These are described together with the other shakings and strokings.

The effects of Abdominal-kneading have been previously spoken of by Dr. Kleen, and I will therefore only recall the most important :—

(*a*) Increased secretion of the digestive juices, and consequently improved digestion.

(*b*) Acceleration of the passage of the intestinal contents.

(*c*) Increased development and strength of the non-striated muscle fibres of the alimentary canal, and consequently permanent improvement in peristalsis and defæcation.

(*d*) Dissolution and absorption of products of inflammation in and around the walls of the alimentary canal.

(*e*) Stretching of adhesions.

(*f*) Improvement of portal circulation (by alternations of pressure in the abdomen).

Abdominal massage is very much used, not only in treatment of diseases of the digestive organs, but also in many forms of general weakness and disturbances of nutrition or circulation, especially of the portal circulation.

Contra-indications (see Stomach-pit-shaking, or preferably Dr. Kleen's account of it).

In connection with Abdominal massage may be described here : (1) A manipulation introduced by Major Brandt and called by him "*S-romanum-lifting*" (Sigmoid-flexure-lifting), and (2) *Anal massage*, given on the sphincter ani and its surroundings.

SIGMOID-FLEXURE-LIFTING.—This is performed by the patient taking Crook-half-lying position with knees drawn well up, in order as much as possible to relax the abdominal wall. The gymnast

stands on the right side of the patient and places the hands in the left iliac fossa, and by degrees goes in deeply under the sigmoid flexure till he can press the rectum against the posterior abdominal wall. While continually pressing backwards he makes a drawing upwards with gentle shaking, causing the patient to feel a slight indrawing of the anus, if the manipulation has the desired effect.

Used in treatment of prolapsus ani, and attempts to replace the part completely and to stimulate the intestinal wall and its surroundings. The prolapsed intestine is pushed back into the sphincter before the manipulation is begun.

Anal Massage.—For this the patient takes a suitable Arm-lean-stoop-stride-standing position against the end of a high plinth or other suitable apparatus. Massage is given round the anus, and consists of small circular kneadings and strokings, alternating with shakings. Also internal vibration done with a vibrator may be used. It is usually not given on the bare skin, but over some covering (underlinen or towel). May be done with the finger-tips or with a short rod. In mild cases the patient can himself do the massage.

Effects and Uses.—(*a*) Products of inflammation, both in the walls of the rectum and its surroundings and in the sphincter and other perineal muscles, are broken up.

(*b*) The shaking causes a mechanical stimulation of the cells of the tissues, so that their activity and tone is increased, which effect may also extend to the other organs in the true pelvis.

Used with advantage in treating hæmorrhoids and prolapsus ani and in coccydynia.

Nerve Pressures, Nerve Frictions, and Nerve Vibrations.

Nerve Pressures may be given as "*General*" and as "*Special*" or "*Local*."

General Nerve-pressures are given on the arms, legs, and back, and down the back of the legs in sequence (in Forward-lying position). They are done by the gymnast grasping the part to be treated with both hands, the crooked fingers like a claw being pressed into the skin with a gentle shaking. In this way the arm and leg or back is treated from above downward two or three times with quickly-repeated pressures. In this one does not aim at treating the special nerve trunks, but only their peripheral branches.

Special or Local Nerve-pressures are given over the large nerve trunks, which are looked for and pressed against the underlying bone. The pressure may either be static (for a few minutes or more), or may be done by the finger gliding quickly forward and

backward transversely across the trunk of the nerve with slight pressure, and in this way producing stimulation of the nerve.

NERVE-FRICTIONS are given along the nerve trunks, and are usually performed by the tips of the first finger and thumb being placed against each other and applied over the nerve so that it lies in a groove between the tips of the fingers, while small frictions are made at right angles to the direction of the nerve trunk as they glide along its course.

NERVE-VIBRATIONS are performed by placing one or more fingers over a nerve and vibrating strongly or finely by small muscular contractions, while the fingers exercise firmer or weaker pressure on the nerve or glide along it. Both frictions and vibrations can with advantage be given by means of a vibrator.

The value of the various manipulations on the nerves is chiefly similar to the effects of hacking on nerves spoken of above (see General Effects of Hacking), that is :—

(*a*) The nerve path to the corresponding cells in the spinal cord and brain are brought into action and receive increased nutrition.

(*b*) Various reflexes arise, which possibly stimulate different parts of the body, among others the heart.

(*c*) In local stimulation of motor nerve trunks the corresponding muscles may be made to contract, and their nutrition and functional power are thus increased. This is effected chiefly by special nerve pressures.

(*d*) Products of inflammation in nerves and their surroundings are broken up and absorbed. This is chiefly brought about by nerve frictions.

(*e*) Finally, continuous pressure on a nerve trunk, if given strongly, can break its power of carrying impulses (probably through pressure on the axis cylinder), and in this way stop or diminish cramp and pain.

For these reasons nerve-pressures, etc., *are used* in treatment of various diseases both of the brain and spinal cord and of the peripheral nerves ; in paralyses of all kinds, to try to maintain functional power in the muscles and nerves until the brain can take up its power again over them ; in tabes and other diseases of the spinal cord, to improve the nutrition of the nerve paths and to maintain their functional power as long as possible ; in neuritis, neuralgia, cramp, etc., to break up the products of inflammation in and around the nerves, or to diminish their irritability. Finally, they have also been used in treating heart diseases, in order by reflex action to stimulate the heart.

Some reminder of those places where the more important nerves

may be most easily met with and are accessible to treatment may here be given.

Supra- and Infra-trochlear Nerves are met with behind the orbital margin at the upper and lower inner angles of the orbit.

Nasal Nerve, at the side of the nose at the lower border of the nasal bone.

Supra-orbital Nerve, at the supra-orbital foramen or notch, and in its course from this point in front of the frontal bone (lower and more obliquely outward than one is inclined to think). It can even be got at inside the orbital margin if the masseur's finger-tips are not too thick.

Infra-orbital Nerve, at or quite near to the infra-orbital foramen (pressure should be directed obliquely upward and backward).

Auriculo-temporal Nerve, immediately in front of the ear along the hair margin.

Mental Nerve, at the mental foramen (almost straight below the angle of the mouth).

Facial Nerve, around the region of the stylo-mastoid foramen (under the ear behind the lower jaw).

Spinal Accessory Nerve, a little behind and below the middle of the posterior border of the sterno-cleido-mastoid, just where the nerve goes in below trapezius.

Great Occipital Nerve, about 1½ cm. from the middle line and 2 to 3 cm. below the occipital protuberance. From this point the nerve can be followed a little way obliquely upward and outward.

Lesser Occipital Nerve, at the posterior border of sterno-cleido-mastoid, at its insertion on the mastoid process.

The *Brachial Plexus* is found in the supra-clavicular fossa immediately below the middle of the posterior border of sterno-cleido-mastoid, and in the axilla just behind coraco-brachialis. Pressure is directed here towards the inner surface of the humerus.

Radial (*Musculo-Spiral*) *Nerve*, on the outer side of the arm at the upper border of brachio-radialis, and from this point a little way upward and downward in the spiral groove.

Median Nerve, in front of the elbow joint, close to or somewhat internal to the biceps tendon, and from here up the arm in the internal bicipital sulcus.

Ulnar Nerve, between the internal condyle and the olecranon, and from there upward and downward a little way.

Thoracic or Dorsal Spinal Nerves.—The superficial branches of the posterior primary divisions are found beside the spinous processes. The lateral cutaneous branches of the anterior primary divisions (intercostal nerves) are found in the axillary line at the lower border of the corresponding ribs. The anterior terminal

branches of the intercostal nerves are to be found at the side of the sternum, or the external border of the sheath of the rectus (the lower intercostal nerves).

Crural Nerve, just below and about 1 cm. external to the middle of Poupart's ligament, and from here slightly downward and inward towards the internal condyle of the femur.

Sciatic Nerve, slightly internal to the mid-point between the tuberosity of the ischium and the great trochanter, and from this point along a line going towards the middle of the popliteal space. (*N.B.*—About the middle third of the thigh the nerve is covered by the inner head of biceps femoris, which crosses it.)

Tibial Nerve (internal popliteal) is to be met in the middle of the popliteal space and in the groove between the two heads of gastrocnemius (here it is difficult to get at). Where gastrocnemius becomes the Achilles tendon the external branch can be got at in the mid-line (N. suralis). The main trunk can be felt again below the inner malleolus.

Peroneal or *Ext. Popliteal Nerve* is felt behind the head of the fibula, and may here be followed a little way upward and forward.

Arm-lean-standing
Forward-lying } *Spinal Nerve-pressures.*

Given with closely adducted finger-tips, or with the dorsal surface of the middle phalanx of the flexed fingers, as a series of pressures, with trembling or shaking down both sides of the spine. Repeated three to four times.

Effects and Uses.—Practically the same as Back-hacking.

Stroking.

As has been mentioned before, the strokings spoken of below are as a rule centrifugal, and consequently differ from the effleurage strokes of massage. They are usually given with the palmar surfaces of the hand and fingers, and are performed either slowly with slight pressure for soothing the nerves, or quickly and with rather strong pressure for stimulating. We may specially mention :—

Forward-lying
Arm-lean-sitting
Arm-lean-standing } *Back-stroking.*

Performed as longitudinal stroking from above downward, usually with one hand on each side of the spinal cord, but also given by both hands stroking right over the spinous processes either both together or one after the other. Repeated several times.

In the opinion of the earlier gymnasts Back-stroking was held

to be most effectual for counteracting night sweats (connected with nervous disturbances).

Grasp-standing
Lying
Half-lying
} *Transverse-abdominal- and Colon-stroking.*

TRANSVERSE-ABDOMINAL-STROKING is done by the gymnast, beginning at the pit of the stomach and going down over the abdomen, giving a series of rather strong semi-circular strokes from the middle line out towards the sides almost parallel with the ribs. In this at the beginning of every stroke first the heel of the hand, then the palm, and finally the fingers touch the abdominal wall.

COLON-STROKING is given along the course of the large intestine from the cæcum to the sigmoid flexure. These strokings aim at producing a mechanical stimulation of the walls of the intestine, especially the muscular layer, so that peristalsis is increased. Colon-stroking aims also at giving a direct onward impulse to the intestinal contents.

LUMBAR-SIDE-STROKING is given along the sides, over the ascending and descending colon from above obliquely downward and forward. This also aims at stimulating the underlying parts of the intestine.

All these strokings are commonly employed to supplement Abdominal-kneading.

GENERAL SOOTHING STROKINGS.—These are given over the whole body while the patient lies with the arms close to the sides and eyes shut. They begin at the crown of the head and are continued down the sides and front of the body to the feet, and are given slowly and with the very slightest pressure. The patient should be told to notice the direction of the stroking attentively.

It is used to calm nervous patients and in the treatment of sleeplessness. In the latter case it is best when the patient has gone to bed.

Summary of Movements specially used in the Treatment of Spinal Curvatures.

Movements to Correct Kyphosis.

A. EXERCISES WHICH STRETCH THE LIGAMENTS AND OTHER SOFT PARTS IN FRONT OF THE SPINAL COLUMN AND THORAX :—

1. ARCH-HANGING POSITION and all movements in this.
2. STRETCH-GRASP-STANDING FORWARD-DRAWING.
3. ALL CHEST-EXPANSIONS.
4. HANGING WITH A CUSHION AT THE BACK (Fig. 126).—The patient takes Hanging starting position at a peg-post or in the

middle of the upright between two wall-bars, and a little hard cushion is pressed in between his back and the apparatus at the maximum point of the kyphosis. The effect can be increased by pushing the patient's pelvis back against the apparatus. It is taken continuously for five to ten minutes or more. The longer the patient can hang the better will be the effect.

Fig. 126.

B. Exercises which Cause Active Work (in shortening) for the Muscles at the Back of the Spine and Thorax.

1. Neck-firm or Neck-rest Position of arms, and all movements in this position. But it must be carefully noticed that the correct position of the head is not lost throughout the exercise.

2. Neck-raising in its various starting positions.

3. Stretch-stoop-grasp-standing Holding.—The patient places himself in front of a wall-bar or peg-post at one and a half steps distance from the apparatus. After taking up the position (Arm-stretching-upward Trunk-falling-forward in the hip-joint) and grasping the apparatus he tries to straighten out the back as much as possible by pressing the thorax down while the sacrum is pushed backward. The gymnast, standing at the side, watches and corrects the position, especially of the head.

4. Wing- / Neck-rest- } Arch-leg-forward-lying Holding.

5. All Back-raisings.

6. All 2 Plane Arm-carryings.—These latter specially correct the position of the shoulders.

Exercises to Correct Lordosis.

A. Exercises which Stretch Ligaments and Soft Parts at the Back of the Lumbar Spine.

1. Wing- / Neck-rest- / Stretch- } standing Trunk-bending-forward-downward.

Knees should not be bent. "Last bit, the best bit."

2. Hewing.—Patient, in Stretch-stride-standing position with hands together or clasped, bends himself quickly forward and downward as if he were giving a vigorous hewing, and relaxes at the same time the back muscles, so that a strong stretching of the back is produced. Repeated six to twelve times.

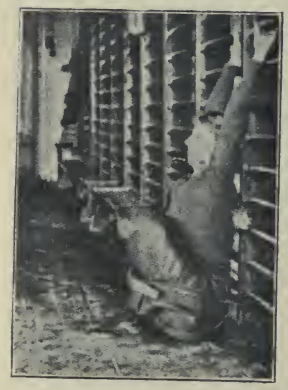

Fig. 127.

3. { Heave- } grasp Crook-sitting { Stretch- } Position (Fig. 127).—Done at a peg-post or at the upright between two wall-bars. The patient sits on the ground with the back close to the apparatus and the knees drawn up to the trunk. Then the knees are pressed back by means of a strap going behind the apparatus, which is fastened in front of the legs, after which the arms are carried to Heave or Stretch position and grasp the apparatus. For this the gymnast usually must help.

If kyphosis and lordosis are both present a little cushion is pushed in between the maximum of the curve and the apparatus. The position should be maintained for some time—five to ten minutes or more.

B. Exercises with Active Work (best in Strong Contraction) for the Abdominal Muscles.

In general all exercises for flexors of the trunk (see p. 229), but especially :—

1. All 2 (double) Knee-updrawings and -downpressings.
2. All 2 Leg-liftings and -downpressings.
3. All 2 Leg-updrawings and -downpressings.
4. Climbing.
5. General Correcting Position = G. C. P. — The patient places himself in Stride-standing position with the back against a post or the corner of a door, or something similar, with the feet a little in front of the support. With the trunk bent slightly forward the sacrum is first pressed against the apparatus, then the spinous processes of the lower lumbar vertebræ, and so on, vertebra by vertebra, while the trunk is raised. The patient should try to keep the lumbar vertebræ closely applied to the apparatus while the upper vertebræ come in contact with it. It is controlled by the gymnast, or the patient himself, by putting the finger-tips along the lumbar spine between it and the support.

After some practice the feet are placed nearer to the apparatus and Stride position is diminished. Finally, 2 (double) Arm-heaving-forward and -upward is done with the whole spine pressed against the apparatus. This exercise is very effective.

Exercises to Correct Lateral Curvature of the Spine = Special Scoliosis Movements.

For giving special exercises in scoliosis treatment the following general rules apply :—

(*a*) The patient's back must be uncovered, so that both the performance of the movement and its effect can be directly controlled with the eyes.

(*b*) All "pressure" must be continuous and even, sometimes with small pressures at the maximum point, but never roughly or with the knuckles.

(*c*) Pressure on a dorsal curve is given at the angles of the ribs, not in the middle of the side. Pressure on a lumbar curve is given on the transverse processes (that is, quite close to the spinal column).

Exercises which Increase the Mobility of the Joints of the Spinal Column, and thus prepare for and facilitate Scoliosis Treatment.

1. All Forms of Hanging, especially Hanging in a Head-suspension Apparatus (Fig. 128). —For this the leather collar is first applied, surrounding the patient's neck and chin. Then the patient stretches up the arms, and the transverse rod is placed so high that the patient can just reach it and grasp it with both hands. By slightly increasing or diminishing the distance between the rod and the collar, which can be done by fixing the rod higher or lower, and by regulating the length of the straps which support the collar, one may allow more or less of the weight of the body to be borne by the hands, and consequently diminish or increase the tension on the head or cervical spine.

Fig. 128.

When the apparatus is adjusted it is raised to such a height that the patient can just reach the floor on tip-toe. At first the patient is not able to hang long in this position, but afterwards the time may be considerably extended, even to ten to fifteen minutes. The gymnast must all the time be ready to lower the patient when he shows signs of fatigue, for if the patient lets go his hands, and the whole weight of the body is thus supported by the cervical vertebræ, a severe accident may easily arise by rupture of ligaments or by dislocation.

Apparatus for self-suspension is also made, but, as the weight in this is borne equally between the hands and the cervical spine and cannot be regulated, this apparatus is not so useful; neither do the patients like it, but always prefer the above method of suspension.

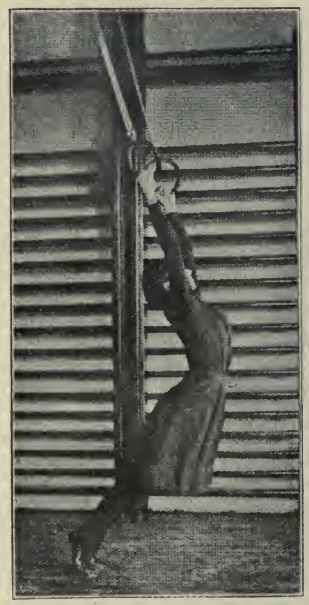

Fig. 129.

The *effect* of this hanging is of course to produce a strong tension of the ligaments and soft parts of the spinal column, especially in the cervical region.

2. Rolling in Rings, Ropes, etc. (Fig. 129).—The patient stands between the rings or ropes, which he grasps with more or less extended arms, when he allows his body to perform a circular movement, first one way and then the other, while the feet remain all the time on the same spot.

3. Trunk-rolling and Circle-turning.

4. Head-rolling.

5. Quick alternate Trunk-turning (best in Yard-stride-standing position).

6. Hewing (see Movements for Lordosis.)

7. Sawing.—This is performed by the patient, after having taken "Reach position" of the arms, slowly bending forward and rising again, while performing repeated strong side-turnings of the trunk and with the arms performing a movement as in sawing, the arm of the shoulder going backward being bent and carried back, while the other arm is stretched forward (always at right angles to the trunk). The whole is repeated two to four times.

Exercises which cause Double-sided Work for the Back Muscles.

They are used in treating a tendency to curvature, as well as in the different forms of scoliosis.

1. All Double-sided Back Exercises (see Exercises for the Extensors of the Trunk).

2. All Double-sided Arm Exercises, especially 2 Arm-bending- and -stretching (see these exercises, p. 220).

3. { Wing-standing / Neck-rest-standing / Stretch-standing- } Heel-raising and Knee-bending.

Performed slowly and with the greatest possible precision; if necessary, helped by the gymnast.

4. Correction in Belt (see Exercises for S-shaped Scoliosis, p. 287).

Exercises for a definite simple Dorsal Curve (Convex to the Right).

A. Exercises which Stretch the Ligaments and Muscles on the Concave (Left) Side = Stretching Movements.

1. Side-lying over Boom (Fig. 130).—The boom, furnished with a padded cushion, is placed at the level of the middle of the curve. The patient is placed across the boom with the highest point of the convexity immediately over the cushion, and turned slightly to the convex (right side), so that the pressure is applied to the region of the angles of the ribs in a direction from behind and outward obliquely forward and inward.

Fig. 130.

With the arm on the convex (right) side the patient grasps the boom; with the other hand stretched over the head and flexed at the elbow he grasps the handle of a strap fastened to the floor. The gymnast, especially at the beginning, must often support the patient's legs with his own knee or in some other way. He can moreover increase the effect of the exercise by careful pressure in front on the bulging ribs of the concave side. The longer the patient can remain in this position the better.

2. Stretch-grasp-side-against-standing Forward-drawing (right side against) (Fig. 131).—The patient stands with the right side turned towards the wall-bars or peg-post, with the hands grasping the handle of a so-called Forward-drawing-strap (see Gymnastic

Apparatus). The gymnast stands facing the patient's left side with one foot supported against the apparatus, and encircles the thorax, grasping it at the level of the maximum convexity. The patient is now turned so much to the left that the pressure which is exerted by the heel of the gymnast's posterior (right) hand at the angles of the ribs works, as in the preceding exercise, in a direction obliquely forward and inward as the gymnast draws the patient straight out from the apparatus.

Fig. 131.

B. Exercises which partly Stretch the Ligaments and Soft Parts on the Concave Side, partly give Work in Strong Contraction for the Muscles on the Convex Side.

1. (Left) Neck-firm-h.-r.-s. Side-bending (to right) with pressure (Fig. 132).—The gymnast stands behind the patient, places the right foot on a stool, and supports the right elbow against the knee, while the right hand, with extended wrist and fingers flexed at the metacarpo-phalangeal joints, is placed on the dorsal curve (at the angles of the ribs). With the left arm he grasps the patient just below the left axilla to help him with the side-bending. The gymnast now presses the dorsal curve strongly

Fig. 132.

Fig. 133.

inward and forward by carrying in his right knee, while the patient at the same time, with the help of the gymnast's left arm, performs small side-bendings to the right. (*N.B.*—The side-bendings, on account of the pressure in the back, can only be done to a slight degree, and the patient's trunk is throughout almost upright.)

Fig. 134.

2. (Left) Neck-firm (Left) Side-leg-lying Correction with pressure + Side-arch-leg-lying Holding (Fig. 133).—When the patient has been placed in the starting position the gymnast, standing behind, grasps him with his left arm from below, just below the axilla; the right is placed, as in the preceding exercise, on the angles of the ribs on the convex side at the maximum convexity. At this point firm pressure is exerted obliquely forward and inward, while the patient makes small forcible side-bendings (to the right) assisted by the gymnast's left arm. Care must be taken to avoid any forward rotation of the upper shoulder. Finished by Side-arch-leg-lying Holding.

C. Exercises with Active Work, chiefly for the Muscles on the Convex (Right) Side.

1. (Left) Neck-firm (Left) Hip-lean-walk-st. Side-bending (to right) with pressure (Fig. 134).—The patient takes (left) Walk-st. position, with (left) hip supported against a boom. The gymnast stands on the other side of the boom and grasps the patient's thorax at the middle of the curve, and with the heel of one (right) hand, assisted by the other, gives firm pressure on the angle of the ribs obliquely forward and inward, while the patient performs forcible Side-bendings to the right.

Fig. 135.

2. (Right) Wing-stoop-std.-sitting (Left) Arm-upstretching and -downpressing (see Single Arm-upstretching, p. 223).

3. Free-standing (Left) Shoulder-lifting (Fig. 135).—The gymnast stands behind the patient and with one hand (right) gives

pressure on the convexity; with the other (left) he grasps the patient's (left) wrist and gives resistance, while the latter lifts his left shoulder and at the same time contracts the back muscles on the right side, so that the curve is straightened out or even bent to the left. The patient then resists slightly while the gymnast draws the shoulder down again to the starting position. (*N.B.*—This movement is a combination of Shoulder-lifting and Side-bending.)

Fig. 136.

D. Exercises which Correct Deformity of the Thorax by Pressure.

1. Hanging Correction by Diagonal Pressure on the Thorax (Fig. 136).—The gymnast stands in Fall-out position behind the patient and gives pressure with his (right) hand on the angles of the ribs on the convex side, obliquely forward and inward. An assistant gives counteracting pressure from in front on the protruding ribs of the opposite (left) side.

Can also be given to the patient in Standing position by one gymnast. The patient's arm on the concave (left) side is then carried slightly forward so that it lies against the protruding ribs in front of the thorax. The gymnast stands on the patient's (left) side, encircles him with both arms, and gives pressure with the hands on the angles of the ribs on the convex (right) side, while he presses him against his own chest, which gives the counter-pressure in front.

Exercises to Correct Single Lumbar Curve (Convex to the Left).

A. Stretching Movements.

1. Side-lying over boom.

2. Stretch-grasp-side-against-st. Forward-drawing.

These are both given in a similar way to the corresponding exercises for a dorsal curve, but modified according to the position of the curve.

Fig. 137.

3. Hanging Passive 2 (double) Leg-carrying to (left) side with pressure (Fig. 137).—Best given at a wall-bar. With one hand (right) the gymnast gives firm pressure forward and inward on the lumbar convexity; with the other (left) he grasps the patient's legs and carries them to the (left) side and slightly backward. At the extreme limit of movement a few over-stretchings are made. (*N.B.*—The pressure must be given on the transverse processes near the spinous processes, and so firmly that the trunk remains fixed while the legs are carried to the side.)

4. Forward-lying Passive 2 (double) Leg-carrying to the (left) side with pressure (Fig. 138 shows Leg-carrying to the right).—Two gymnasts, standing at the patient's (left) side. One gives pressure with one hand (right) on the lumbar curve forward and inward, and with the other (left) hand fixes the patient's trunk. Grasp immediately under the (right) axilla. The other gymnast grasps the patient's legs and carries them to the (left) side as in the preceding exercise.

5. Standing Weight-carrying on to the Leg of the Convex Side.—By quickly bending the knee on the concave (right) side and carrying the weight of the body over to the other (left) leg the patient himself reverses the curve, if it is still mobile, so that the originally concave (right) side is stretched. Repeated several times with a "jerk." (*N.B.*—The side-flexion of the spine must take place in the lumbar region and complete stretching of the spine be made between each weight-carrying.)

6. (Right-) Neck-firm (left-) Spring-sitting Trunk-rolling with pressure (Fig. 139).—The gymnast stands behind the patient and steadies the posterior leg by grasping it between his

own. With one (left) hand flexed at the metacarpo-phalangeal joints he gives pressure on the convexity of the lumbar spine ; with the other he grasps the patient below and in front of the shoulder

Fig. 138.

Fig. 139.

on the concave (right) side, and helps by pressing the trunk over to the convex side while the patient performs the rolling. (*N.B.*— Rolling is done more strongly towards the convex side.)

B. Exercises which partly Stretch the Ligaments and Soft Parts on the Concave Side, and partly Work the Muscles of the Convex Side in strong Shortening.

1. (Right-) Neck-firm-h.-r.-s. Side-bending (to left) with pressure.

2. (Right-) Neck-firm (Right-) Side-leg-lying Correction with pressure + Side-arch-leg-lying Holding.

These are both performed in a similar manner to the corresponding exercises for a dorsal curve, naturally with such modifications as the position of the curve requires.

C. Exercises with chiefly Active Work in strong Shortening for the Muscles on the Convex (left) Side.

1. (Right) Neck-firm (right-) hip-lean-walk-standing Side-bending (to left) with pressure.—Given like the corresponding exercise for a dorsal curve, but the pressure is naturally given on the lumbar part of the spinal column.

2. Hanging Active 2 (double) Leg-carrying to (left) side (Fig. 140 shows Leg-carrying to right).—The gymnast stands

behind the patient and resists with one hand above the patient's ankles; with the other (right) hand he supports the patient's hip (at the right side). The patient carries both legs to the left as far as possible against resistance of the gymnast, who afterwards presses them back to the starting position against the patient's resistance.

Fig. 140.

3. Stretch-grasp-lying or Reach-grasp-standing (left) Hip-updrawing.—The gymnast grasps the patient's ankle (left) and resists while the patient draws up the hip and leg as far as possible; then the gymnast draws down the leg to the starting position against the resistance of the patient.

4. High - reach - grasp - standing (left) Leg-outward-carrying and -inpressing (see Leg Exercises, p. 206).

5. (Right-) Stretch- (left-) spring-sitting Holding (see Starting Positions, p. 184).

Exercises for a Cervical Curvature (Convex to the Left).

A. Stretching Movements.

1. Hanging-in Apparatus (see Movements which increase the mobility in the joints of the Spinal Column, p. 277).

2. Head-rolling.

3. Passive Head-side-bending (to left) with pressure on the convexity.

Fig. 141.

B. Exercises chiefly with Work in Shortening for the Muscles of the Convex (left) Side.

1. (Left) Talk-grasp-standing Active Head-side-bending (to left) and -raising (Fig. 141). — Given so that the muscles work concentrically and eccentrically in shortening, *i.e.*, in the inner part of their range of movement (see Head-side-bendings). This form is used if the left shoulder is raised.

2. (Left-) Crutch-standing Head-side-

BENDING (TO THE LEFT) (Fig. 142 shows bending to the right). —Used when the left shoulder is lower than the right (when the cervical curve is compensatory to a severe primary dorsal curve).

FIG. 142.

Exercises for S-shaped Scoliosis (Right Dorsal, Left Lumbar).

A. STRETCHING MOVEMENTS.

1. LEG-FORWARD-LYING CORRECTION WITH PRESSURE ON BOTH CURVES (Fig. 143). (*N.B.*—Convexity of the upper curve in this case to the left).—The patient grasps the hips of the gymnast, who stands in front of him (head close to the right hip). The gymnast grasps with one hand (right) just below the patient's (left) axilla and carries his trunk first slightly over to the (right) side, when an assistant lays his hand (flexed at the metacarpo-phalangeal joint) on the lumbar curve and gives firm pressure. The patient's trunk is now carried over to the left while pressure on the lumbar curve is maintained, so that a strong stretching is produced on the concave side.

The upper convexity is pressed by the free hand of the gymnast firmly inward and forward by pressure on the region of the angles of the ribs, while the upper part of the trunk is bent to the right. In this way there is also correction of the upper curve.

FIG. 143.

2. FORWARD-LYING PASSIVE 2 (DOUBLE) LEG-CARRYING TO (LEFT) SIDE WITH PRESSURE ON BOTH CURVES.—Given like the corresponding movement for a simple lumbar curve (p. 283), but with this difference, that an extra assistant gives pressure on the upper curve.

Chiefly affects the lower curve, but is not used much because respiration is considerably hindered by the pressure on the upper curve causing compression of the patient's chest.

B. Exercises which partly Stretch the Soft Parts of the Concave Side, partly give Work to the Muscles of the Convex Side.

1. (Left-) Neck-rest-h.-r.-s. Side-bending to the side of the upper curve (right) with pressure on both curves.—Given similarly to the corresponding exercise for a dorsal curve, but an assistant gives firm pressure on the lumbar curve throughout. Affects chiefly the upper curve.

Fig. 144.

In this group may also be reckoned :—

2. Neck-rest- (or Left-neck - rest - right - wing -) stoop - leg - lean - standing Back-raising with pressure on both curves (Fig. 144). — The gymnast, standing behind the patient, gives pressure with his hands on the convexities of the curves, while the patient raises the trunk as in ordinary Back-raising. Often the pressure is given so strongly that an assistant, standing in front of the patient, must help in raising, at least during the last part, by pressing in front of the patient's shoulders.

Fig. 145.

C. Exercises with chiefly Active Work in Shortening for the Muscles on the Convex Side of the Curves.

1. (Left-) Stretch- (left-) fall-out-standing Holding (see Starting Positions, p. 171).

2. (Left-) Stretch- (left-) spring-sitting Holding (see Starting Positions, p. 184).

3. Correction in Belt (Fig. 145).—The correction belt consists of a broad pelvic girdle, to which two handles are attached, one on each side. The belt is strapped

round the hips so that it rests between the iliac crests and the great trochanters. In carrying out the correction the patient is first told to push back the lumbar spine so that it is quite straight; slight forward flexion facilitates this for a beginner. Then he is told to lower the shoulders and draw them well back. He now grasps the handles with slightly bent arms, and, carefully maintaining the position with lumbar spine pushed back and shoulders low and drawn well back, he stretches the elbow joints, so that the whole of the upper part of the body is raised and the spine stretched. In this position the patient must now contract the back muscles first on the side of the lumbar convexity (gymnast touches the place with one finger and says, "Draw in here!"), and then in the same way for the dorsal curve. When the back has been corrected in this way the patient, maintaining the corrected position carefully, may do Heel-raising and a few short steps forward on the toes, lowering the heels and raising them again between each step. After a short necessary rest the correction is repeated again. If it is done carefully and with strong contraction of the muscles it is a very tiring, but very effective, exercise. It must always be carefully supervised. If the patient is allowed to do it by himself it may easily produce lordosis. Can also be used for other forms of scoliosis.

Fig. 146.

D. Exercises which Correct by Pressure the Deformity of the Thorax and also the Curves.

Hanging Correction with pressure on both curves and counter-pressure on front of thorax.—Given like the corresponding exercise for a single dorsal curve, but another gymnast gives pressure on the lumbar convexity.

Exercises for Rotation of Pelvis combined with a Lumbar Curve.

A. Stretching Movements.

Hanging Correction of Pelvic Rotation.—(*a*) If the hip on the side of the lumbar convexity is rotated forward (Fig. 146) the upper part of the body is fixed by a gymnast, standing on the side of the backward-rotated hip, grasping the patient's trunk, so that the heel of the posterior hand, with the help of the other hand,

presses the lumbar convexity forward and inward, while another gymnast, with the same grasp as in ordinary pelvic rotation, performs rotation of the pelvis, *i.e.*, pushes the forward hip backward and draws the backward hip forward. Repeated several times.

Fig. 147.

(*b*) If the hip on the opposite side to the lumbar convexity is rotated forward (Fig. 147), the upper part of the body is fixed by one gymnast, who grasps just below the patient's shoulders (one hand on the front of the shoulder on the convex side, the other behind the other shoulder). Another gymnast, standing at the side of the forward hip, grasps the patient and exerts pressure on the convexity of the lumbar curve as described in the preceding exercise, while at the same time he presses the forward hip backward with his own chest. Repeated several times.

B. Exercises with Work in Strong Shortening for those Muscles which correct Rotation of the Pelvis.

Heave-grasp close-standing
Stretch-grasp-close-standing } Hip-forward-turning.

The backward rotated hip is turned forward as far as possible, the other backward.

The gymnast stands in front of the patient and lays one hand in front of the hip which is to be turned forward, the other at the back of the opposite hip. The patient now turns the pelvis against the resistance of the gymnast, so that the posterior hip comes as far forward as possible and the anterior hip as far back, after which the gymnast turns the pelvis back to the frontal plane, but no further, against the resistance of the patient. Repeated four to six times.

Exercises which Raise a Low Shoulder.

1. Neck-rest or Stretch position for the arm on the side of the low shoulder.

2. (Left-) Talk-grasp-standing (Right-) Shoulder-lifting

(if the right shoulder is low).—The gymnast stands behind the patient and lays one hand on the low shoulder; the other grasps the wrist. The patient now raises the shoulder as high as possible against the resistance of the gymnast, who then draws it down again to normal position (not lower) against the resistance of the patient.

List of "Between Exercises" which the Patient can take by himself during Treatment for Scoliosis.

1. Wing-standing Trunk-bending-forward and -raising.
2. Standing Arm-stretchings.
3. Hanging.
4. Sawing.
5. Hewing.
6. Slow marching, with Heel-raising, Knee-bending-upward, Knee- and Ankle-stretching (Cock-walk).
7. Balance-walking, along a line on the floor, on a boom (flat side) or other special apparatus.
8. Neck-rest or Stretch-standing Heel-raising and Knee-bending against wall, door-post, etc.
9. General Correcting Position = G. C. P. These have been already described.

Some Exercises grouped according to their Effects.

Respiratory Exercises.

These may be divided into :—

(*a*) Those which help inspiration.

(*b*) Those which specially help expiration.

(*c*) Those which help interchange of gases in the lungs.

For the general effects of respiratory exercises, see Standing 2 (double) Arm-carrying-forward-upward-outward-downward (p. 217).

Exercises which help Inspiration.

The exercises mentioned below are not all exclusively exercises for inspiration, but many of them at the same time also assist expiration or interchange of gases in the lungs, or both. Neither are all the exercises mentioned which in some degree assist inspiration, but only the most important.

1. Chest-lift-stroking.
2. Chest-lift-shaking.
3. Chest-lifting.
4. Circle-turning.
5. Grasp-standing Forward-drawing.

6. Chest-expansions.
7. Yard-sitting 2 (double) Arm-rolling.
8. Standing 2 (double) Arm-carrying-forward-upward-outward-downward or Outward-upward-outward-downward.
9. Stretch-sitting 2 (double) Arm-bending-stretching.
10. Plane Arm-carrying.
11. Trunk Bending-forward and -raising, and generally speaking, all Back-raisings.

Exercises which specially help Expiration.

1. Chest-lift-stroking.
2. Chest-lift-shaking.
3. Side-chest-shaking.
4. Stretch-grasp-standing Forward-drawing.
5. Stretch-sitting 2 (double) Arm-bending-stretching.
6. Trunk-bending-forward and -raising and other Back-raisings.

Exercises which help Interchange of Gases in the Lungs.

1. Chest-lift-shaking.
2. Side-chest-shaking.
3. Chest-clapping.
4. Back-hacking.
5. Back-clapping.
6. Screw-twisting.

Exercises which influence Circulation of the Blood.

These may be divided into :—

A. Exercises which help circulation in general.
B. Exercises which specially help pulmonary circulation.
C. Exercises which help portal circulation.

A. The General Circulatory Exercises may be divided into :—

(*a*) Exercises which stimulate the Heart to stronger Contraction, and consequently aid Circulation, especially in the Arteries.

1. All active movements, with or without resistance.
2. Heart-hacking.
3. Nerve pressures.

(*b*) Exercises which promote the Venous Return.

1. All passive movements, especially rollings.
2. All exercises for inspiration (increase the negative pressure in the thorax).

3. Effleurage.
4. Kneadings.
5. Active movements also directly assist venous circulation.

B. Exercises which specially help the Pulmonary Circulation.

These consist of all respiratory movements which assist inspiration or expiration, or both.

C. Exercises which help the Portal Circulation.

1. Circle-turning.
2. Trunk-rolling.
3. Abdominal kneading.
4. Most Trunk exercises, because they produce alternate lengthening and shortening of the blood vessels in the abdomen, as well as alternation between increased and diminished pressure in the abdomen.

Exercises which specially influence the Distribution of Blood in the Body.

Among these there are three large groups :—

A. Exercises which deplete the head.

B. Exercises which deplete the abdominal and pelvic organs.

C. Exercises which replete the abdominal and pelvic organs.

In arranging the last two groups I have principally followed the opinions of Major Brandt.

A. Exercises which Deplete the Head.

1. All active movements which exercise large masses of muscles without impeding respiration. Such are specially :—
   (*a*) Strong Leg exercises.
   (*b*) Back exercises.
2. Neck massage.
3. Head-rolling and Neck-raising.
4. Head-hacking.
5. Inversion (momentary).

This is done by turning the patient upside down for a moment and then raising him again, so that the amount of blood in the head is diminished by the contraction of the blood vessels owing to reaction.

6. Pressure on the Jugular Vein (momentary) acts in the same way as the preceding. Formerly much used, but less so now. Great care is necessary.

B. Exercises which Deplete Abdominal and Pelvic Organs.

1. Stoop position, and, in general, movements given in this position.

2. Exercises performed chiefly by the Gluteal and Back muscles; Back-raisings, Leg-parting and -inpressing, etc.

3. All active Arm exercises which do not impede respiration.

The strongest effect is gained if all the above actions are combined, *e.g.* :—

Yard-stoop-stride-sitting 2 Plane Arm-carrying.
Stretch-stoop-stride-sitting 2 Arm-bending-stretching.
Yard-stoop-stride-sitting Back-raising.
Heave-stoop-stride-sitting Alternate Trunk-turning.

C. Exercises which Replete Abdominal and Pelvic Organs.

1. Arch position and, in general, all exercises in this position.

2. All active movements where Ilio-psoas works (see Movements for Flexors of the Hip joint, p. 196).

3. In general all strong Leg exercises, except those performed chiefly by the Glutei.

4. Leg-rolling.

5. Strong Sacral-beating.

6. Low or High Knee-arch-stride-standing Screw-twisting. This works very strongly.

Exercises which Soothe the Heart.

1. Stroking over the region of the heart.
2. Tapôtement *à l'air comprimé* in slow rhythm
3. Fine vibrations over the heart.
4. Back-hacking and Back-tremble-shaking.
5. All exercises which help venous circulation.

Exercises which Aid Digestion and Peristalsis.

A. All exercises which aid portal circulation (p. 292).

B. All active abdominal exercises. Partly by increasing pressure in the abdomen and thus stimulating the walls of the alimentary canal, partly by associated movement between the external abdominal muscles and the non-striated muscle fibres in the stomach and intestines.

C. All movements and manipulations which cause direct stimulation of the organs of digestion.

(1) Abdominal kneading.

(2) Stomach-pit-, Stomach-,Transverse-abdominal-, and Lumbar-side-shaking.
(3) Transverse-abdominal-, Colon-, and Lumbar-side-stroking.
(4) Wing-stoop-stride-sitting Screw-twisting.
(5) Exercises with Abdominal and Lumbar pressure.

General Rules for making a Medical Gymnastic Table.

In the medical gymnastic treatment of a patient we do not usually limit ourselves to giving only what may be called special exercises, *i.e.*, exercises and manipulations which aim at directly affecting the patient's complaint, but we extend the treatment as a rule to the whole organism, and give a so-called *General Strengthening Gymnastic Treatment.* This includes the whole body, and its objects are :—

1. To increase the supply of oxygen to the body in order to increase general metabolism.

2. To promote the activity of the organs of digestion, so as in this way to increase and facilitate the preparation and absorption of food substances, and thus make better use of the food.

3. To assist general circulation and consequently the distribution of food substances to the various parts of the body, so that nutrition everywhere is improved.

4. To produce general increase in the activity of the cells, either by direct mechanical stimulation of the organs and tissues by hacking, clapping, shaking, kneading, and other similar manipulations, or by reflex action, by suitable stimulation of the sensory nerves, *e.g.*, by back-hacking, general nerve pressures, etc.

5. If the patient's strength allows, active movements for the large muscles of the extremities and trunk are also included in the treatment.

In arranging the treatment for a patient one chooses in this way a number of movements and manipulations, usually about eight to twelve in number, and comprising some with direct influence on the changes present, while the rest make up a general treatment on the above principles.

For the sake of regularity and supervision they are put together suitably as a table which the patient can go through daily, and preferably at the same time of day.

In drawing up such a table care must be taken :—

1. That the strength of the treatment is carefully adapted to the patient's strength.

2. That movements with similar effect are not placed immediately after each other.

3. That a movement or manipulation which aims at affecting directly the nervous system, or at producing certain reflex effects (*e.g.*, Head-hacking, Nerve-pressures, Back-hacking), is not immediately followed by an active movement in the same part of the body, as the effects of the first exercise or manipulation may then easily be counteracted or spoilt by the active movement following. (*N.B.*—In treating paralysis, however, muscle and nerve massage and passive movements are given before the active movements in order to raise the functional power of the muscles, nerves, and joints and so facilitate movement.)

4. That the easier movements are placed at the beginning and end of the table, the harder ones in the middle.

5. That the same table is not kept too long unchanged, but is revised and strengthened as the patient's strength increases.

6. That the treatment, as far as possible, is not hastily broken off, and that the table is made easier towards the close of treatment, so that the patient leaves off gradually.

For my own part as a rule I have followed in the main the scheme for tables given below, proposed by that methodical gymnast, L. G. Branting.

1. Respiratory exercise.
2. Exercises for the extremities, preferably for both upper and lower extremities.
3. Exercises or manipulations which affect the abdomen and its organs.
4. Exercises or manipulations affecting neck or head.
5. Exercises or manipulations affecting back or chest.
6. Exercises for the extremities.
7. Respiratory exercise.

N.B.—One or two extremity exercises are often put in the middle of the table, so that too many trunk exercises may not follow closely upon one another.

Naturally the scheme must not be slavishly followed, but can and ought to be modified according to the necessity of special cases. I have included it here because I know from experience what a great help it is, especially for beginners, in arranging a table of exercises.

CHAPTER X.

METHODS OF MEDICO-MECHANICAL GYMNASTICS.

By Emil Zander.

I. Technique.

The main principles in the technique of Swedish medical gymnastics are *localisation* of movement, *i.e.*, to restrict it to a definite joint and group of muscles, and its *graduation* according to the strength of the muscles and the requirements of the individual case.

While *Ling* employed trained "medical gymnasts" to give the movements, *i.e.*, the manual method, the medico-mechanical method founded by *Dr. Gustaf Zander*, so far as possible, while following the same principles underlying all medical gymnastics, endeavours to replace the gymnast by apparatus of a mechanical nature.

When a special active or passive movement is given, in most cases the *rôle* played by the gymnast is of a purely mechanical nature. In most cases the most suitable positions are decided once for all, and the direction of the movement is determined by the anatomical construction of the parts under consideration. In resistance movements the resistance given is of variable strength; on the one hand it must be given according to the physique of the patient, and, on the other hand, moderated, as we shall see later, according to the power of the working muscles in different parts of the movement. These two requirements, as we shall soon see, can be fulfilled with ease and with greater certainty by mechanical appliances.

On these principles, then, the mechanical method is founded, and the apparatus is constructed accordingly with a view to fulfilling the following requirements:—

(1) To maintain a correct starting position in the widest sense.

(2) To guarantee that the movement shall be performed in a correct anatomical direction.

(3) In resistance movements, to produce a resistance which on the one hand can be modified from the weakest to the strongest, and on the other hand to alter it during the movement according to anatomical and physiological requirements.

Besides the apparatus used for *movements* the mechanical

system comprises appliances constructed for special *massage* effects, such as hacking, kneading, stroking, and vibration, and apparatus for giving *corrective pressure* (orthopædic apparatus). Finally, it comprises three machines specia'ly devised for *examining* lateral curvatures.

Medico-Mechanical Gymnastic Apparatus.

The gymnastic apparatus constructed by Dr. Zander consists of seventy-three machines, and they are divided into the following groups :—

1. *Apparatus for Active Movements.*

A. Arm movements.
B. Leg movements.
C. Trunk movements.
D. Trunk-balancing movements.

2. *Apparatus for Passive Movements.*

E. Passive movements.

3. *Apparatus for Massage Effects.*

F. Shaking ; vibration.
G. Hacking ; beating.
H. Kneading.
I. Stroking ; rolling or light kneading.

4. *Orthopædic Apparatus (for Scoliosis).*

K. Passive correction.
L. Active correction.

The apparatus used for examining are :—

Trunk Measuring Apparatus.—An instrument used for measuring the trunk to ascertain deviations of the vertebral column affecting head, trunk, etc.

Transverse Measuring Apparatus.—An instrument for transverse measurement of the trunk, showing the shape of the chest at different heights.

An Examining Chair, the seat of which can be adjusted in different side-slanting positions to see their effects upon the spine.

To facilitate the writing of prescriptions and for the benefit of the patient each apparatus is numbered and lettered, the letter telling to which of the eleven groups the apparatus belongs, and the number its place in the group, *e.g.*, A1 = Arm-carrying-outward downward (with resistance).

In a text-book such as this it is neither necessary nor suitable to give a detailed description of all these various gymnastic or

examination apparatus.* A brief description only will be given of the most important apparatus in so far as it is necessary for the reader to understand the medico-mechanical method of treatment.

1. Apparatus for Active Movements.

The manual method of gymnastics recognises two kinds of active movements, Free and Resistance (p. 157). For the former no apparatus is required. The apparatus for resistance exercises are the most important and characteristic of the medico-mechanical system, and consist of thirty-one machines (exclusive of those used for active orthopædic treatment, which latter, for convenience' sake, will be described under that heading).

Besides the purely active form of *Resistance exercises*, the mechanical method uses two groups of movements, known as the half-active, half-passive exercises, which are not used in the manual method—viz., *Pendulum movements*, regulated by apparatus, and the sitting *Trunk-balance movements*, both of which forms have been introduced by Dr. G. Zander into gymnastic therapy; and are described as *active* because the patient is doing a certain amount of active work.

The apparatus for *Active exercise* is divided into three main groups: Resistance, Pendulum, and Trunk-balancing apparatus.

Resistance Apparatus.

To describe accurately the principles on which such apparatus is constructed it is necessary to recall such points in the physiology of movement as are of importance as a basis for these exercises.

In most active movements (not considering the muscle contraction of the antagonists) it is necessary to make a distinction between the muscles in primary and secondary action. By the muscles acting primarily we mean those muscles which perform the movement with motor contraction, positive (shortening) or negative (lengthening). The muscles acting secondarily are those which are required to fix the parts concerned by static contraction, *e.g.*, in Arm-lifting-sideways the Deltoid contracts to raise the arm, and Serratus Anticus Major (with the assistance of others) is in static contraction in fixing the scapula, so that the acromion, the origin of Deltoid, is fixed and does not displace or annul the movement. If the arm be lifted from the horizontal to a vertical plane,

* Those who are interested may be referred to "Medico-Mechanical Gymnastics," a manual for teachers and patients of the Med.-Mech. Institute, by E. Zander: Stockholm, 1899, price 1 kr.

Serratus Anticus Major is now the primary worker and contracts positively, and the Deltoid works statically to fix the part.

This example illustrates the co-operation between primary (motor) and secondary (static) muscle work. The localisation of the muscles in secondary action is not always so limited ; there are cases where the primary movement does not depend upon co-operation with the secondary, but upon other conditions. In 2 Arm-carrying-forward with resistance (Arm-closing, A5) the movement itself is done by Pectoralis Major and the anterior portion of the Deltoid. If the patient sits on a seat with the back unsupported, in order to maintain the erect position against resistance of the gymnast or apparatus on the front of his arms he must contract the abdominal muscles and Ilio-psoas. The effect then of the movement is not limited to the joint concerned, but is contrary to the principles of Swedish gymnastics in regard to localisation of movement, and should therefore be avoided. This is easily done by supporting the patient's back, when the movement becomes at once localised, making extra muscle work unnecessary.

The objectionable secondary contractions are not always so extensive as the above, and are more easily overlooked. In active flexion of the forearm, if support be not given to the lower portion of the upper arm from behind, Pectoralis Major will contract in order to prevent the upper arm yielding to the resistance pressure on the wrist. This again is a complication which is against all the Swedish gymnastic laws of localisation.

In this is seen the importance of the first principle on which gymnastic apparatus is constructed (see p. 296). The apparatus must be so constructed that in using it the patient takes the most comfortable position suitable both for the body as a whole and for that part of the body which is concerned in the movement, *i.e.*, he must be well supported, while the movement is not hampered. In constructing the apparatus Dr. Zander has not overlooked this important fact, and in this his system differs from nearly all others.

The second condition which governs the construction of the apparatus is that the movement shall take place in the correct anatomical path. The importance of this need not be further explained. I have already pointed out that it is a necessary condition in the construction of the apparatus.

Lastly, we come to the third point, that it must be possible on the one hand to alter the resistance to suit the patient's strength, and on the other hand that it must be varied during the movement, according to anatomical and physiological conditions.

This latter is accomplished by a rather more detailed treatment.

The problem of the changes of the strength of the movement during

an exercise arises as a gymnastic problem with the mechanical method. This has never before been discussed in gymnastic literature, probably because the gymnast can apportion the resistance according to the patient's strength by his own sensation, and during the movement in the same way he varies his resistance according to the patient's varying power to overcome it. One of the differences between a good and bad gymnast is shown in this power of thus varying resistance, a hard enough matter; on this depends to a large extent whether the exercise is given smoothly and evenly, and consequently beneficially to the patient, or not. Every uneven resistance causes the patient extra innervation to the working muscles, which in its turn causes extra work for the brain in comparison to the almost automatic work when the resistance is even and reliable. This is especially important in the treatment of nervous or heart patients.

Apparatus providing resistance must be constructed with reference to these requirements. Constant resistance, such as that given by friction blocks or weights suspended from pulleys, is not felt to be of the same strength throughout the entire exercise, but is stronger at some parts than at others.

The reason for this is found in several facts, of which I shall only mention two.

The first is of a purely mechanical nature, and depends on the construction of the joints and on the position of the insertions of the muscles on the bone and the existence of trochlear surfaces for the tendons, etc. The bones are the levers on which the muscles work. If the bone is at right angles to the direction of the muscle contraction its whole power takes effect in movement, but the more oblique the angle, whether acute or obtuse, at which the muscle acts between the lever and the tendon, the greater is the loss of muscle power from the movement. The effect of muscle contraction is diminished or increased throughout the movement according to the alteration of this angle.

Another cause of alteration in the effect of muscle work is expressed in Schwann's law, which states that the muscle during contraction continually loses force. When at its longest it can lift a greater weight than when shorter.

In order that the movement produced should be even and agreeable, the resistance appliance in each apparatus must be so constructed that the resistance during the exercise varies along with the power of the muscle to overcome it. In Dr. Zander's apparatus this effect is obtained by the use of levers to which weights are attached. The connecting link between the lever and the patient is made by means of a special shunting mechanism for each apparatus, so that when the patient performs the exercise desired the lever is raised and thus offers a certain definite resistance.

The arrangement of levers serves two purposes.

First, the graduation of the resistance given becomes on the whole very easy, as the weight may be pushed further along the lever or nearer to its axis, according to whether a weak or strong exercise is desired, and it can be fixed by a metal screw. As the lever is graduated there is also, as opposed to the "manual" gymnastics, an objective measure-

ment of the strength of the exercise according to the number on which the weight is placed. The length of the lever and the size of the weight are adapted to the greatest or least amount of resistance for the exercise in question.

The other purpose of the lever is to fulfil the requirement just explained, *i.e.*, that the resistance must be varied during the performance of the movement. This is made possible by the fact that the resistance of the weight to the raising of the lever (rotation round its horizontal axis) varies according to the inclination of the lever to the horizontal. If the lever hangs straight down, this resistance is *nil;* when the lever is turning upward this increases by degrees till it reaches its maximum, when the lever becomes horizontal; if the rotation is continued, it diminishes again, and again becomes *nil* when the lever points directly upward. If a lever with such a path of movement is applied to a resistance apparatus, the resistance from being *nil* at the beginning would slowly increase and be greatest in the middle of the exercise and then decrease, to become *nil* again at the end of the exercise. Such an arrangement is not to be found in connection with the Zander apparatus, as no gymnastic exercise requires resistance varying in this way. But the example serves to point out what possibility of variation the leverage arrangement offers; *e.g.*, if I want resistance to be gradually decreased throughout the exercise, I let the lever lie horizontally at the beginning of the exercise, and from this position rise through a larger or smaller angle, according to the relation in which the resistance at the beginning should stand to the resistance at the end. If I want a resistance which increases somewhat at first and then diminishes, I begin with the lever pointing downward at an angle suitable to the conditions. And so on according to what is desired. One must remember that the total angle described by the lever during the performance of the movement does not correspond in extent with that described by the patient. By means of the shunting apparatus one can make any relationship between these two angles; in some apparatus the first is greater than the second, in others *vice versa*. The whole problem of construction is concentrated on these two points—the relation between the patient's and the weight-lever's angle of movement and the angle of inclination at which the latter begins and ends the movement. The question with each apparatus is that these points should be most suitably arranged so as to obtain the best resistance, *i.e.*, the resistance which seems most even and comfortable for the performance of the movement. Many prolonged experiments

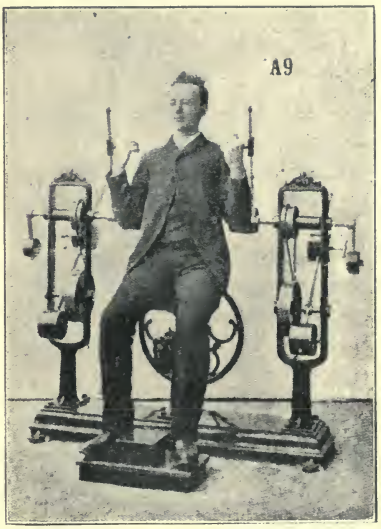

FIG. 148.

were required to obtain the definite results now shown in the apparatus.*

From the above description of resistance apparatus it follows that although the apparatus works by means of pressure in a definite direction, all movements consist of two phases—the first, positive or concentric, when the muscle shortens, overcoming the resistance of the apparatus; and the second, negative or eccentric, when the muscle lengthens, by degrees giving way to the pressure of the apparatus. As distinct from the manual method, where concentric movements in general are used much more than eccentric, these different forms of work are used

Fig. 149.

Fig. 150.

methodically in the medico-mechanical apparatus to a precisely similar extent, *i.e.*, continually alternating in every movement. If for any definite purpose it is required to use one form of work only, this may be done easily by an assistant grasping some of the movable parts of the apparatus and performing the opposite phase of movement instead of the patient.

The forms of apparatus used by Zander for resistance exercises are the following :—

A1. Arm-lifting-outward.

A2. Arm-raising, Shoulder-lifting.

* I have gone somewhat deeply into these questions in order to make clear the difference between apparatus on the one hand specially constructed for medical gymnastics, and on the other hand a number of "gymnastic apparatus" of many kinds, more or less pretentious, which are to be obtained cheaply. Common to them is the fact that they more or less neglect the above requirements, which are rightly demanded of apparatus for medical gymnastics. They content themselves with obtaining a resistance which is nearly always based upon the use of elastic ropes, spiral springs, or such devices. All these arrangements have this fault, that the resistance throughout the movement perpetually increases, so that it is strongest at the end of the exercise, *i.e.*, when the patient's power of work is least. That they can be used without discomfort by healthy persons to strengthen muscles and give exercise is undoubted. For real medical gymnastic purposes they should be discarded as not fulfilling the simplest requirements in this direction.

A3. Arm-downdrawing.
A4. Arm-stretching-upward.
A5. Arm-carrying-forward.
A6. Arm-carrying-backward (Arm-parting).
A8A. Arm-turning (rotation).
A9. Forearm-flexion.
A10. Forearm-extension.
A11. Wrist-bending and -stretching.
A12. Finger-bending and -stretching.
B1. Hip-flexion.
B2. Hip-stretching.
B3. Hip-updrawing.
B4. Hip-downpressing.
B5A. Sitting Leg-adduction.
B5B. Crook-half-lying Leg-adduction.
B6. Leg-abduction.
B8. Leg-rotation.
B9. Knee-flexion.
B10. Knee-extension.
B13. Foot-flexion, -extension, -inversion and -eversion.
C1. Sitting Trunk-flexion.
C2. Sitting Back-raising.
C3. Long-sitting Trunk-flexion.
C4. Long-sitting Trunk-backward-falling.
C5. Lean-standing Back-raising.
C6. Trunk-side-flexion.
C7. Trunk-rotation.
C8. Pelvis-rotation.
C10. Neck-extension.

The accompanying illustrations will serve to indicate the nature of the apparatus :—A9 (Fig. 148), B9 (Fig. 149), C5 (Fig. 150) (see also Figs. 168—171).

Pendulum Apparatus.

Pendulum movements are brought about by the patient himself performing the described movement, thus setting in motion the apparatus, of which the swinging part (balance-wheel or pendulum) continues the movement owing to its inertia and carries the patient's body with it in its motion. For the continuance of the movement only slight muscular exertion is required, a condition in which these movements differ from all other kinds of active movements. For this reason they are termed " momentarily active " instead of " continuously active " movements.

The movements are either circular (rolling), or in the form of a pendulum (flexion and extension). In both cases the original Zander apparatus is provided with a balance-wheel which continues the movement. Later apparatus (after Krukenberg's type) consists of a pendulum arrangement fixed to the above-mentioned resistance apparatus to allow of pendulum movements.

Fig. 151.

The apparatus constructed for this purpose alone are :—

A7A. Arm-rolling.
A7B. Hand-rolling.
A8B. Arm-alternate-turning.
B7. Cycling.
B11. Foot-flexion and -extension.
B12. Foot-rolling.

Pendulum arrangements are constructed for the following apparatus :—

A9 and A10. Forearm-flexion and -extension.
B9 and B10. Knee-flexion and -extension.
B13. Foot-flexion, -extension, -inversion and -eversion. An illustration is given of B12 (Fig. 151).

Apparatus for Trunk Balancing Movements.

The patient places himself on an apparatus in a sitting position. The apparatus, driven by motor power, is set in motion, making the seat slope in different directions. The patient's pelvis takes part in the swaying movement, and in order to keep his position he is obliged to make a series of contractions in all the muscles of the trunk and pelvis, to balance the trunk on the pelvis. The muscle contractions are the active part of the exercise ; the passive part are those movements which take place in the lumbar spine, and also a slight massage of the abdominal viscera.

The apparatus constructed for these exercises are three :—

D1. Trunk-bending (forward, backward or laterally).
D2. Stride-sitting Trunk-rolling.
D3. Ride-sitting Trunk-rolling. An illustration is given of D3 (Fig. 152).

2. Apparatus for Passive Movements.

Some of the apparatus mentioned in groups A, B, and C can be used for purely passive movements also. An assistant can set the apparatus in motion by using the weight lever or a specially-made handle attached to certain machines for the purpose; or when shortened ligaments and muscles have to be stretched the apparatus can be used to give constant pressure in a definite direction of move-

Fig. 152.

Fig. 153.

ment by means of the loaded weight lever. If, for example, a bent knee has to be straightened, the patient is put into the apparatus for Knee-flexion (B9), and is told to slacken the flexors of the knee and to let the resistance weight press in the opposite direction, *i.e.*, stretching the knee.

For a few special passive exercises there are specially-constructed apparatus, all of which except one (E4) are worked by motor power. E4 is worked by an assistant, or even by the patient himself with his free hand. The apparatus are :—

E2. Hand-alternate-flexion and -extension.

E3. Hand-abduction and -adduction.

E4. Hand and Finger-flexion and -extension.
E5. Leg-rolling.
E6. Chest-expansion.
E7. Trunk-rotation.
E8. Pelvis-raising.
Fig. 153 illustrates E6.

3. Apparatus for Massage Effects.

In close connection with movement proper in the Swedish system, the gymnast since Ling's day has used a series of pro-

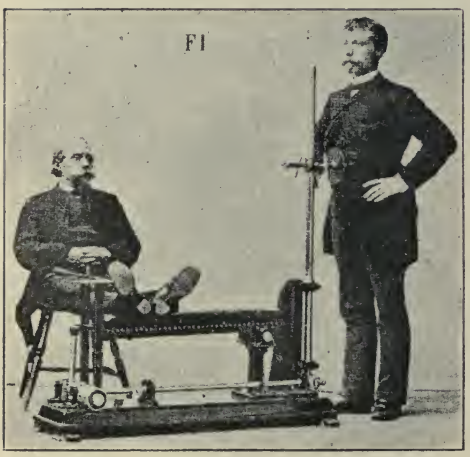

Fig. 154.

Fig. 155.

cedures (hacking, vibration, kneading, etc.), which, though called by him passive movements, are not really movements in the technical sense of the term, but rather massage manipulations. In a gymnastic prescription they are often inserted here and there among the movements proper, as they are often quite as important as the latter.

The following apparatus have been constructed for such purposes, not actually to replace "manual" massage.

F1. Vibratory Apparatus.
F2. Ride-shaking.
G1. Trunk-hacking.
G3. Leg-hacking.

G4. Back and Arm-hacking.
G5. Head-hacking.
H1. Abdominal-kneading.
J1. Arm-sawing (or rolling).
J2B. Finger-stroking.
J3. Leg-sawing (or rolling).
J4. Foot-stroking.
J5. Back-roll-stroking.
J6. Abdominal-circular-stroking.

We give the following illustrations :—F1 (Fig. 148), G1 (Fig. 155), J1 (Fig. 156), J6 (Fig. 157).

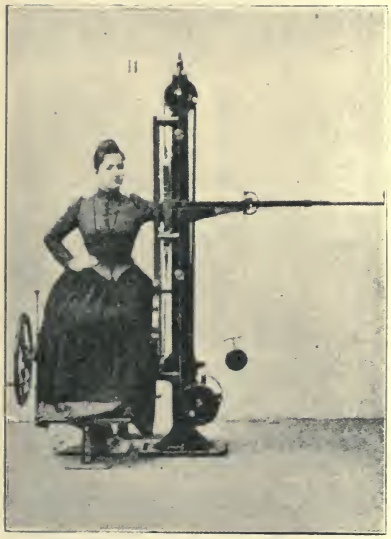

FIG. 156.

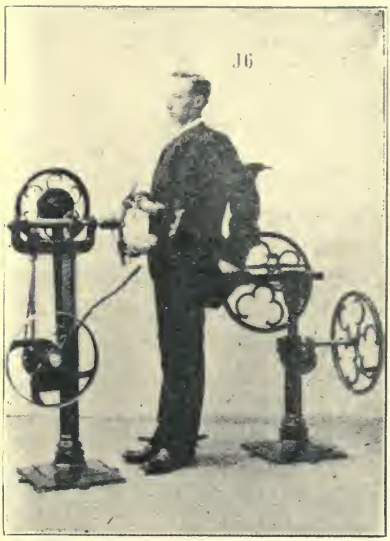

FIG. 157.

4. ORTHOPÆDIC APPARATUS.

In the third division of this chapter an account is given of the orthopædic apparatus, which is used solely for scoliosis treatment.

I have here given a short review of the medico-mechanical gymnastic apparatus. Its therapeutic use is founded on the same principles as all gymnastic treatment. The two subjects about to be described, the Treatment of Heart Disease and Scoliosis, are probably the most important. The first may be treated briefly, since its principles and treatment are the same as those of the "manual" method which was described above ; the second more

in detail, since the mechanical method provides means of treatment to which nothing in the " manual " method corresponds.

II. The Treatment of Heart Disease.

The medico-mechanical treatment of heart disease is, like the manual, founded partly on physiology and partly on experience. For the sake of clearness and to avoid repetition I will only mention the chief points to consider in ordering gymnastic treatment for a heart patient, in order to point out under each heading the corresponding medico-mechanical movements.

The various ways in which the gymnast tries to alleviate the condition of the patient's heart can be grouped under four principal headings :—

(1) Aiding the Circulation of the Blood and Lymph.

This helps the work of the heart, improves nutrition of the tissues, and gets rid of œdema. The slowing of the blood stream is the main cause of all pathological disturbances in heart cases. An increase of its speed is therefore of great importance. By means of gymnastics this can be effected :—

(*a*) In a purely mechanical way by movements and manipulations which produce a rhythmical compression with alternate passive and active dilatation of the veins, whereby the blood is pumped towards the heart, directed by valves.

(*b*) In a reflex way by the use of active movements, whereby the blood stream in the working muscles and the blood vessels leading to them dilate and resistance is thus lessened.

The medico-mechanical movements to fulfil these indications are as follows :—

Arm-kneading (J1), Leg-kneading (J3), Leg-hacking (G3) ; these manipulations have a purely passive effect through the rhythmical compression of the muscles of the arm and leg, by which the blood and lymph are driven on in a centripetal direction.

Foot-stroking (J4) and Foot-shaking (F1) cause primarily or secondarily a dilatation, and thus lower the resistance offered in the blood vessels of the foot and leg.

Hand-rolling (A7B), Passive Hand-flexion and -extension (E2), Passive Hand-adduction and -abduction (E3), Arm-rolling (A7A), Arm-alternate-rotation (A8B), Leg-rolling (E5), Passive " Cycling " (B7), Passive Foot-flexion and -extension (B11), Foot-rolling (B12) ; all these exercises are more or less passive, and help the circulation

by means of the co-operation between the fasciæ and the valves of the veins (see chapter on Physiology).

Passive and Active Trunk-rotations (E7, C7, C8), Pelvis-tilting (D1) and Trunk-rolling (D2 and D3), assist the abdominal circulation by the rhythmical compression of the viscera. Abdominal-circular-stroking (J6) and Abdominal-kneading (H1) act almost in the same way.

Trunk-raising (C2 and C5), Trunk-side-flexion (C6), and Chest-expansion (E6) are respiratory movements—the first two active, the third purely passive in character. They assist the systemic and pulmonary circulation, of which more will be said.

Finally we may here mention some active movements for the exercise of muscles as such. They have the same effect as the movements in Section (3), and will be there specified.

(2) The Stimulation and Regulation of the Heart's Action by Direct Influence on it.

This is due to the empirical fact that certain local procedures have been shown to influence the action of the heart. Vibration and hacking over the region of the heart (F1 and G1) have a regulating influence on the rhythm and frequency of its beat. Back-vibration (F1) (between the shoulder-blades) has a slowing influence almost immediately on a too rapid heart-beat. In cases of a very irritable heart, especially when it is dilated, these methods, especially heart-vibration, cause somewhat unpleasant sensations (a feeling of oppression, giddiness, etc.). This is not a contra-indication for treatment, which should be discontinued for a time only, until the patient has become used to it by gentle and brief treatment; in quite a short time it will be found effectual.

(3) The Strengthening of a Weakened Heart.

By systematically increased active movements, which may be termed "progressive training" of the heart muscle. This indication, which can only be carried out if the heart has some reserve force, is common to gymnastics and the "Terrain-cure." The advantage of the gymnastic method is that it can be begun with much weaker active movements than walking on level ground. It is easy to increase the exercises slowly and gradually until the maximum strength of the patient is reached, and it is just in this choice of exercises that the skill of the gymnast lies. The strength of a movement depends on two things: first, the amount of

resistance used, and, secondly, the size of the muscle groups brought into action. The following is a list of exercises which are used for this purpose (it increases in progression from the weakest to the strongest) :—

Arm movements : Hand-rolling (A7B), Hand-flexion-extension (A11), Arm-rotation (A8B), Elbow-extension (A10), Elbow-flexion (A9), Arm-rotation (A8A), Double-arm-carrying -forward and -backward (A5 and A6).

Leg movements : Foot-rolling (B12), Leg-rotation (B8), Knee-flexion and -extension (B9 and B10), Hip-knee-extension (B4), Leg-adduction (B5), Hip-knee-flexion (B3), Leg-abduction (B6).

Trunk movements : Sitting Trunk-extension (C2), Trunk-side-flexion (C6), Pelvis-rotation (C8), Trunk-turning (C7), Sitting Trunk-flexion-forward (C1), Standing Trunk-extension (C5).

(4) Treatment of other Organs the Condition of which directly Influences the Action of the Heart.

This section deals partly with the digestive system, partly with the respiratory system. Such conditions as chronic constipation and accumulations of gas in the stomach and colon may have a very hampering effect on the work of the heart, and are treated very successfully by medical gymnastics, the local manipulations used being Hacking, Vibration, Kneading, and Stroking (F1, G1, H1, J6).

It also refers to the respiratory system, which is perhaps even more important. It is easy to understand the important relation existing between the respiratory organs and the heart apart from the pulmonary circulation, if one remembers the mechanical part the respiration plays in circulation. During inspiration the blood is drawn in through the large veins towards the heart ; during expiration it is pressed out into the arteries. Upon this depends, on the one hand, the direct effect respiratory gymnastic movements exercise on the circulation, mentioned under (1), on the other hand, the great importance of mobility of the thorax. It may well be a question whether many of the heart symptoms, dyspnœa, palpitation on exertion, which commonly accompany old age, depend upon the rigidity of the chest, which is so common, and which hampers its movements and so impedes respiration. In favour of this view is the obvious effect produced by improving the mobility of the chest. In heart massage, which is considered by some gymnasts of very great value, a forced rhythmical compression of the chest is used, the effect of which is probably due to the mobility of the chest

thus gradually produced rather than to any direct influence on the heart.

To fulfil these indications medico-mechanical gymnastics makes use of various passive and active exercises (E6, C6, E7, C7, C8, C1, C2, C5) already mentioned. Rhythmical manual compression of the chest, preferably performed by the physician, may with advantage be added to this prescription.

The particular exercise chosen must be determined by the needs of each case. The cardinal rule in treatment of all heart disease must be borne in mind—that the functional diagnosis of the case guides the treatment rather than the anatomical diagnosis. One has to think of the degree of circulatory disturbance rather than of the exact form of valvular defect, or the kind of myocarditis which has produced it. It is nevertheless true that certain anatomical conditions are of importance in the treatment. Widespread arterio-sclerosis, coronary sclerosis, aortic aneurism, for example, limit definitely the value of movement. It is dangerous to overstep this limit. All sudden and severe muscular exertion must be avoided, even when the patient is not conscious of weakness. Apart from cases such as these we may lay down the broad general rule that alterations in the functional and reactive power of the heart decide the treatment.

It seems to me conducive to clearness to give here a series of gymnastic tables of a strength graduated according to the reactive power of the heart, beginning with a case where only the gentlest passive movements can be used, going on to a case where the heart, either from the beginning of treatment or by means of the graduated gymnastic training, has such good power of reaction that the treatment approaches an ordinary gymnastic table.

I must, however, first mention two movements which on account of their peculiar efficacy deserve special notice and should never be omitted from any heart table.

The first is E6, Chest-expansion ; the second is J1, Arm-sawing (light kneading). The former acts as a passive respiratory movement, assisting circulation to a large extent, while at the same time it does not strain the patient in any way. If done sufficiently gently at the beginning it is indicated in every case which is in a condition to attend a gymnastic institute, and very few fail to find considerable relief as a result. Arm-sawing is also a movement which works almost like magic. It is not unusual for patients who come to the institute with palpitation, shortness of breath, and sternal pains to find all these disappear under the influence of J1. These two movements, along with Back- and Heart-tremble-shakings, are the triumph of gymnastics, and seldom fail in their

effects. The last mentioned are specially indicated in the case of quick and irregular pulse and of dilatation of the heart (in this case they must be done with the greatest care).

In conclusion I give a series of prescriptions which may serve as an example of a progressive scale. I would point out, however, that special conditions in a particular patient may necessitate additions or alterations which cannot be considered here, where we only aim at giving a general idea of the treatment of heart disease itself. Only the exercises are mentioned, not the numbers, which are included in a complete table showing the position or amount of resistance, which must be decided for each patient separately. At which step in the scale one should begin for a particular patient is also a matter for the individual case, and must be decided by careful observation of his power of reaction. A criterion as to the suitability of the treatment is that the patient should feel refreshed after the treatment and less tired than when he began.

1.	2.	3.	4.
E6.	E6.	J1. Sitting-back-trembling.	J1. B12 (passive).
J1. E6.	J1. J4.	E6. Foot-shaking. J5.	A7B. Sitting-back-trembling.
—	—	—	E6. Foot-shaking. J5.
—	E6.	—	
—	—	—	

5.	6.	7.
J1. E5. Sitting-back-trembling.	J1. B7 (slowly). Heart-trembling.	J1. B8. Transverse-abdominal-hacking.
E2 or E3. E7. Foot-shaking.	A11 or A8B. D1B. J4.	A7A. E5.
		D2. J6.
E6. J6. J5.	E6. Leg-hacking. J5.	E6. Foot-shaking. J5.
—	—	

8.	9.	10.
J1. B9. Back-trembling.	A9. B3 or B4. J1.	A5. B5B. J1.
A8a. B10. E7.	A10. C6, C2, or C8. Lumbar hacking.	A6. B6. Lumbar hacking.
D2. B11. Transverse-abdominal-hacking.	D2. B12. J6.	C1 or C5. B7. H1.
E6. Leg-hacking. J5.	E6. Foot-shaking. J5.	D3. Leg-hacking. E6.

III. Treatment of Scoliosis.

The rational treatment of scoliosis (in the following pages only non-tubercular conditions are considered) requires the assistance of many methods. First among these is gymnastics. Other therapeutic factors, such as massage, forced straightening with or without subsequent treatment by plaster-jacket, various forms of jacket, a sole under one foot, cushion to sit upon, etc., however necessary they may sometimes be, are only indicated in certain cases. Gymnastic treatment, on the contrary, is never useless, unless there is some insuperable difficulty in the way, *e.g.*, infancy, and in nearly every case it is necessary ; also many cases require no other treatment. I will explain somewhat in detail how this gymnastic part of the treatment of scoliosis is carried out in a medico-mechanical institute, but would point out once more that in many cases it must be supplemented by other methods.

First a few words concerning the indications which gymnastic treatment of this disease must fulfil.

Scoliosis is a disease which causes asymmetric changes in bones, ligaments, and joints as well as in muscles. In which of these the scoliotic processes begin is a question which is answered in various ways in different schools, and is still far from decided ; but as the disease develops all these parts are affected. In bone arise the well-known deformities such as wedge-shaped vertebræ and bulging of the ribs ; the ligaments contract or are compressed on one (the concave) side of the curve, and are stretched on the other (convex) side ; the muscles similarly are shortened or stretched, and also lose their tone and elasticity.

To counteract these changes gymnastic treatment aims :—

(1) At mobilising the scoliosis by stretching contracted ligaments and muscles ;

(2) At producing a strengthening and tonic shortening of the lengthened muscles by giving a predominating amount of exercise to them, and in this way causing the patient himself to correct the already mobilised curve by means of his own strength.

On the bone itself gymnastics has no direct influence. But these are not dead, but living parts, and their form may be influenced to some extent, especially during the period of growth. Just as a vertebra from being symmetric has been able to grow wedge-shaped, so it may, to speak boldly, also grow symmetric again. But for this a long time is necessary, and strong work ; " nothing can make a crooked thing straight, but it may be compelled to grow straight " (G. Zander). In order to fulfil this *special* indication plaster bandage or treatment by a jacket is certainly the most effective, but gymnastic treatment also is important in this respect, owing to its powers of improving the habitual position of the patient, and consequently equalising the asymmetric pressure to which the bones are subjected.

According to what has been said above, gymnastic treatment is advantageous in all forms of scoliosis which are not fully fixed, from the simplest early forms to the most severe cases. The improvement which can be obtained varies extremely in different cases, depending on the one hand partly upon the degree which the deformity has reached, partly upon the greater or lesser extent to which the special case lends itself to treatment (an extremely interesting and important matter, which has hitherto been too little considered), and on the other hand upon the insight, perseverance, and energy with which the treatment is carried out. In a great many cases considerable improvement of the deformity can be produced, sometimes practically almost complete correction ; in other cases one must content oneself with less improvement, or even only with the maintenance of the *status quo*, a condition by no means to be despised where it is a question of a disease which in so many cases has a marked tendency to get worse.

The possibility of benefiting a scoliosis patient by gymnastics is not, however, limited to this. There are cases which do not come for treatment until it is too late for gymnastics to have any effect on the deformity, *i.e.*, when the deformity is absolutely fixed. Persons affected with such severe scoliosis usually cannot do much in everyday life, as they easily tire with even the gentlest physical exertion. By means of cont nual and consistent gymnastics, however, these patients obtain considerably increased power of work.

For example, it is found that such patients, after having continued gymnastics for several years, have often attained, certainly not any decrease of their deformity, but sufficient strength for the strenuous work of a medical gymnast or nurse—a better result from the patient's point of view than lessening of the deformity produced by *redressement forcé* combined with a very low power of work.

In passing on to a description of the means which the medico-mechanical scoliosis treatment has at its command we must begin with apparatus designed for measuring the trunk. The treatment is combined so closely with that part of the examination of the patient carried out by means of this apparatus that a short description of it and its uses must precede the description of the treatment.

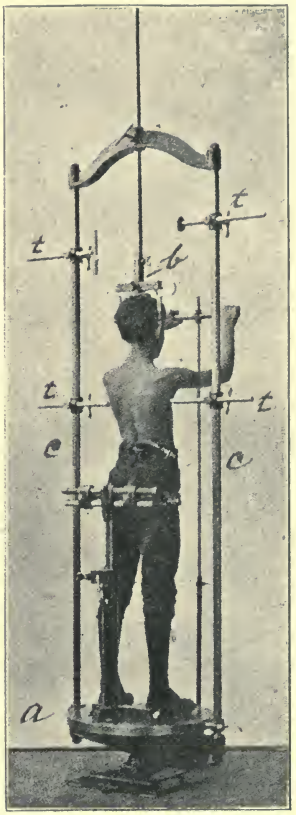

FIG. 158.

The apparatus (Fig. 158) has a foot-piece, *a*, upon which the patient stands; by means of a pair of sliding bars, which can be placed at different heights, the patient's pelvis is fixed in the middle of the apparatus. Above his head is a head-piece, *b*, which, without moving the head from its natural position, is placed so that it exactly touches the crown of the head and embraces the temples, by means of which it partly measures in millimetres the length of the body and the deviation of the head from the middle line, partly fixes the head for measurement in its own position. At the sides of the apparatus there are two parallel vertical poles for measurement of the height *c*, graduated in millimetres and giving the distance above the foot-board. These are combined with one another by means of horizontal cross-pieces one above and one below under the foot-board, and may be turned around the patient and placed in different vertical planes; in so doing the angle of relation of the frontal plane to that marked upon the foot-board is marked as 0°, that of the sagittal plane as 90°. From the movable sockets in the height scale, cross-pieces run in a horizontal direction *t*, forming short measuring-rods, also graduated in millimetres, by means of which the distance of the inner end from

the middle of the apparatus may be read. At this end there are fastened, while measuring different pieces for different purposes, cross-rods, points, and the so-called double measurer, which is used to measure the line of the spinal column, and by means of which the distance of a point from the middle line both in the frontal and sagittal directions can be measured.

Measurement is performed thus :—First those points of the trunk which are to be measured are marked upon the patient's skin with Indian ink. These are: seventh cervical vertebra; the whole line of the spinous processes as far as the coccyx (upper point of the line between the buttocks); on the scapula two points, viz., the lower angle and the angle where the spine of the scapula curves forward as the acromion process. Bulging of the ribs should be marked in its most prominent part; the anterior superior iliac spine on both sides.

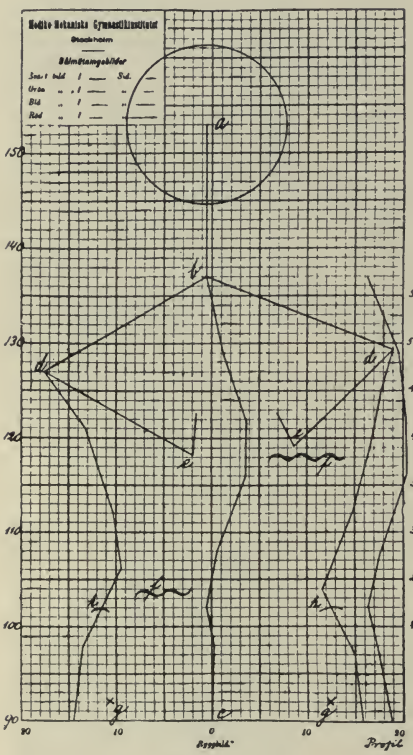

Fig. 159.

The patient is next placed in the apparatus and the pelvis is fixed; the length of the body and the position of the head is read off and the latter fixed. The position of the shoulders is then measured, the two side-contours of the body from the axilla to the great trochanter, seventh cervical vertebra, and the points characteristic of the curve; the height above the foot-board of the prominence of the ribs, both anterior superior iliac spines, and, if necessary, the height of the iliac crest. All these points are marked on squared paper according to the figures which the assistant has taken down in the protocol, and are joined by straight lines. In this way the "measurement diagram" is made, of which Fig. 159 is an example.

Each square corresponds to 1 sq. cm. For reading the height a scale is marked on the left, the "standing scale," which gives the distance above the footboard; on the right there is another, the "sitting scale," which gives the height above the sitting plane.

Point *c* is the coccyx. Through this point the vertical middle line may be considered to be drawn upward. The head *a* is represented by a circle, the upper point of which gives the height of the crown of the head (in this case, therefore, 161·3 cm. above the foot-board, 84·3 cm. above the sitting plane), and the right and left sides give respectively the distance of the temples from the middle line (7·8 and 9·1 cm.). Point *b* represents the spinous process of the seventh cervical vertebra (height 137 and 60 cm. respectively; frontal deviation 0·6 cm. to left). The crooked line *bc* is the line of the spinal column (*i.e.*, the line of the spinous processes); *d* and *e* indicate the acromion process and the angle of the scapula. The waved lines *f* indicate the position of the angles of the ribs; *g* is the anterior superior iliac spine and *h* the iliac crests.

By taking new diagrams from time to time definite data are obtained showing the progress of the case. To facilitate the comparison these new diagrams may be drawn with different coloured pencils on the same paper.

What is the value of such a diagram? Taking for granted that the measurements are carefully and accurately made, a point which necessitates a great deal of experience and much practice,* the diagram gives us a reliable and graphic representation of the deformity as far as it expresses itself at the points measured. The latter is a limitation which must not be forgotten, but which naturally does not apply only to this method of measuring, but to all others. The part of the diagram which is of most importance is the "spinal line," but one must always remember that this line indicates the position of the spinous processes, not of the bodies of the vertebræ. Now we know that in all lateral curvatures there is a tendency to rotation of the vertebræ round a vertical axis, viz., that the bodies deviate more from the mid-line than the spinous processes. The vertebral column (by which I mean the line of vertebral bodies as distinct from the line of spinous processes, which is here called the spinal line) thus forms in the frontal plane an arch with greater deviation from the mid-line, or, more correctly, greater curves, than the spinal line. However, as we possess (apart from Röntgen-rays) no means of directly defining the position of the spinal column, we must content ourselves with the spinous processes. This is, in the majority of cases, sufficiently accurate in practice, as both lines, for the purpose with which we are now concerned, sufficiently coincide. But there are cases where other conditions lead one to suppose that this is not the case, *e.g.*, when the angles of the ribs are prominent while the corresponding part of the spinal line is straight or even

* A measurement such as has been described ought to be done in four minutes after the pelvis is fixed.

slightly bent to the opposite side. Bulging of the ribs definitely indicates a rotation of the vertebral bodies to the same side, with a corresponding side-bending of the spinal column. In such a case the treatment must naturally be directed towards the condition of the spinal column, and not towards that of the spinal line.

However, quite apart from the relative infrequency of the cases where this takes place, this does not lessen the value of the measuring, but only points to the fact that this must be completed by further examination of the patient, particularly in order to estimate to what extent the spinal line may be considered an exponent of the spinal column. The picture itself gives us an idea in this direction, if we examine the position of the angles of the ribs marked upon it in their relation to the spinal line. For ordinary practical purposes such a marking of their position is sufficient. With this apparatus we are not able to obtain any particular picture of the configuration of the chest in horizontal section ; at least, not without further data. For this purpose a special measuring apparatus, the " cross-section measurer," is constructed for use in those cases where it is desirable to have a careful record of this condition.

The above measurement of the patient naturally does not constitute the whole examination. This includes the investigation of other conditions important to a thorough knowledge of the case, such as the condition of the back on bending forward and sideways, the amount of straightening on hanging by the head or arms, the condition of the muscular system, heart, lungs, etc. Finally, it may be pointed out that treatment by Zander's orthopædic gymnastic apparatus for many cases may be carried out without using such a measurement diagram. The prescription for the treatment in these cases must be worked out more in detail, as the patient, with the back uncovered, must be tested upon the apparatus in order to find out the correct position. The diagram is therefore not only of value in diagnosis, but also in prescribing the treatment ; in other words, the special positions for the various apparatus may be written down with absolute certainty that their effects will be exactly what is aimed at. The apparatus is all supplied with scales constructed under the supposition that a diagram is used similar to that described above. The measuring apparatus and the gymnastic apparatus go together, historically and for use ; they are, so to speak, different sides of the same thing, and each loses some of its value if separated from the other.

The apparatus used for scoliosis treatment are some which belong to the general apparatus, as well as some specially constructed for the purpose. These latter are divided, according to their method

of working, into two groups: *K. apparatus for passive correction*, which by means of constant pressure corrects the curves, and in that way stretches the shortened soft parts; *L. apparatus for active corrective movements*, by means of which the spinal column is actively mobilised on the one hand, on the other those muscles are strengthened which have a corrective effect. As all the apparatus, so far as method of working is concerned, belong to one of these two groups, the different apparatus used in the treatment of scoliosis will be described under these groups.

Apparatus for Passive Correction.

K1. Side-hanging (Fig. 160).—The reclining board, *a*, of the apparatus is movable round an axis in its upper edge, and can be

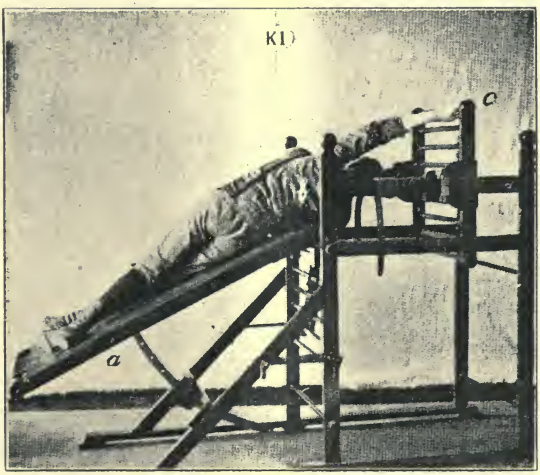

Fig. 160.

placed at various angles of inclination. There is a scale graduated in centimetres of which the zero point is on the inner edge of the padded wooden cross-piece, *b*, the scale showing the distance from this edge. The section of wall-bar, *c*, can be placed at various distances from the cross-piece. In using this apparatus for scoliosis the patient is placed on the reclining board, which is at first horizontal, on his convex side, in a side-lying position, so that the maximum point of the curvature is directly over the cross-piece. The position is held in the following way:—With the arm of the upper concave side the patient grasps the movable wall-bar, which is so placed that the arm is fully stretched. The arm of the convex

side is stretched downward and grasps another bar in the lower section which is immovable. The head rests on a cushion made in saddle form. When the reclining board is lowered (as in the diagram) the spine is flexed over the cross-piece and a correction of the scoliosis thus effected. To prevent too great a compression of the chest the patient lies turned obliquely upward so that the pressure is diagonal, a position which corrects also any " bulging " of the ribs. The slant of the board determines the effect produced by the apparatus. Beginning with a slight slant, it can be increased as the patient becomes accustomed to the procedure. The patient remains lying, or more correctly hanging, from three to five or ten minutes at a time. The procedure is repeated two or three times during each daily treatment, with other movements between.

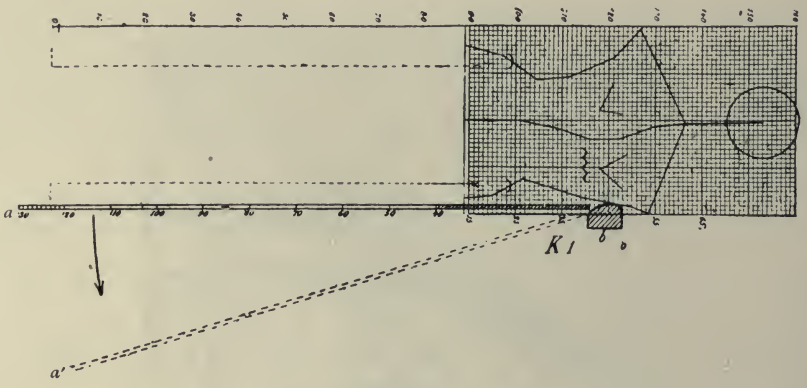

FIG. 161.

The apparatus may also be used for kyphosis. The patient lies on his back with the kyphotic curve over the cross-piece. Both arms are stretched upward and backward, grasping the movable wall-bar. Generally the board can be slanted as much as in scoliosis.

Fig. 161 gives an example of the use of the measurement diagram in connection with the apparatus (K1).* The picture represents a patient with right dorsal scoliosis lying on the apparatus. In the diagram the scale on the left side, the standing scale, is carried down to zero at the footboard. The patient's legs are represented by two dotted lines parallel with the above scale. As will be seen, the maximum of the curve is directly over the cross-piece, *b*, the body is supposed to lie on the board, *a*, which is afterwards lowered in the direction of the arrow, and the patient is prevented from

* The picture, like all that follow, represents a case where the spinal line is the true index to the position of the vertebral column.

falling in the way already described. From the picture it will be seen that the zero, 0, of the apparatus scale must be placed exactly over number 123 of the fixed scale. This gives the distance which should exist from zero to the sole of the patient's foot. This is done by placing the patient in a lying position with the upper edge of the heels resting over number 123 of the scale when the legs are well stretched. All these figures are marked on the prescription and tell the assistant how to place the patient so that one may be sure of obtaining the desired effect. The prescription will read thus :—K1. Right, 123, 25 to 45 (gives the slant).

K2. Side-lying with Pressure (Fig. 162).—The apparatus consists of a rectangular board resting on four feet, of which one half is an upholstered reclining board, *a*, which can be raised at one

Fig. 162.

end (the foot end) round an axis fixed to the other end, and may be fixed at different slopes. It also has a scale showing the distance from this axis. The other half has two or three cushions, *b* and *c*, which can be placed at different distances from the axis and at various heights from the frame. The furthest cushion, *b*, is square and is meant to support the head ; the other, *c*, is smaller and meant for the trunk, while the legs from the iliac crests downward rest on the board, *a*. The patient lies on one side, as in K1, turned obliquely upward, with the maximum deviation of the lateral curve resting on the trunk cushion. By its own weight the trunk is flexed over the supporting cushion and the curve is thus corrected. The strength of the pressure depends on the height at which the cushion is placed. It should begin at 6 to 8 cm. above the level of the reclining board and be gradually increased as required. The patient continues lying from five to ten minutes at a time.

The apparatus is used for lumbar curves, and is then more effective than K1, which cannot affect the spine so low down. It is, moreover, difficult with mere side pressure to correct the curvature between the lower lumbar vertebræ and the pelvis. The pelvis should in this case be made to rotate round its sagittal axis when the lower part of the spine is fixed ; this can be done by K2. When the patient has been placed in the position described, the foot-piece of the board on which the legs and the pelvis rest is raised, the pressure of the trunk cushion preventing the lumbar vertebræ from moving out of position.

Fig. 163 is an example of the use of the measurement diagram in connection with K2. The patient with a left lumbar curvature deeply inclined towards the pelvis rests on his left side with the curve against the cushion, *c ;* the legs from the iliac crest rest on the reclining board, *a*. The patient is first placed with the iliac

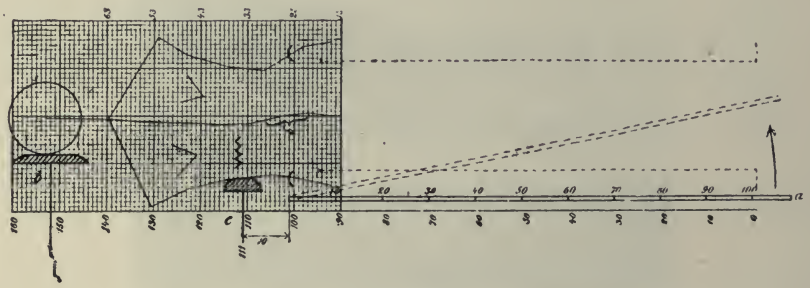

Fig. 163.

crest exactly over the edge of the board. This can be done with fair accuracy by palpation of the crest. It is, however, safer to estimate from the diagram the height of the crest above the foot-board—in this case 101 cm. As the scale of the board begins from the edge, the patient is so placed that the soles of his feet when his knees are stretched reach the number 101 on the scale, and this number is marked on the prescription. After that the position of the trunk-cushion is decided, and especially its distance from the iliac crest. In this case it is 10 cm. above the crest. When one refers to the scale of the apparatus for the height of the middle of the cushion one finds it must be placed on number 10 on the horizontal scale. The height by which the pressure is determined is empirical, and is tested when the patient is lying in position. The head-cushion is placed in a comfortable position for the patient, and its position need not be noted on the prescription. To influence the lowest part of the curve, denoted by *i*, the board

is raised in the direction of the arrow. The prescription will read thus :—

$$K2.\ \textit{Left},\ 101\ ;\ \frac{\textit{Dist.}\ 10}{\textit{Height},\ 8\ (?)}\ ;\ \textit{Angle of inclination},\ 20°.$$

K3. Lying Rotatory Pressure (Fig. 164).—This apparatus aims at directly correcting the rotation of the thorax which often accompanies lateral curvature. The patient rests on a slanting board, suspended by the head and arm-pits, so that the spine is stretched. Two cushions (one behind, the other in front) are pressed against the prominence of the ribs. Lying at the two ends

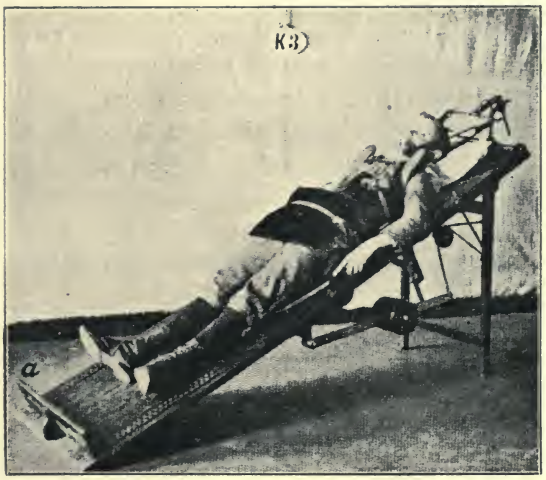

Fig. 164.

of the lengthened diagonal of the chest, they aim at compressing this diagonal, at the same time expanding the chest in the direction of the opposite shortened diagonal. The cushions are pressed against the patient's body by a lever, on which an easily modified pressure can be put by means of a weight at varying points. The cushions can of course be placed in either diagonal (the right behind and the left in front, or *vice versa*). They can moreover be placed at different distances from each other to fit various sizes of chest. The patient is placed in the apparatus so that the middle of the backward prominence of the ribs comes just over the back cushion. To make the patient rest comfortably there is a foot-board at the lower end of the reclining board, placed at a height according to scale, on which the patient's feet are supported ; the higher the foot-board is placed the higher the patient lies and the lower is the

pressure of the cushion on his back. The arm supports are pushed right up to the arm-pits, the head is fixed in Glisson's apparatus, and the pelvis fixed with a strap. The foot-board is then removed, and the patient hangs in the required position from his head and arms (see Fig. 164). The foot support scale has its zero point at the lowest edge of the board, where the distance upward to the middle of the back cushion is 135 cm. If the foot-board be moved higher, for example to No. 10, the above distance becomes diminished to 125 cm., etc.

The patient lies from five to ten or fifteen minutes in the apparatus, and should often take deep breaths so that the diameter of the chest on which there is no pressure may be duly expanded.

Fig. 165 shows how the measurement diagram is used in prescribing the apparatus. The patient, as is shown by the two waved lines, has an upper prominence of the ribs corresponding to the right dorsal and a lower prominence corresponding to the left lumbar curve. If the apparatus is used for the dorsal curve, we must ascertain the height of the maximum deviation—in this case 114 cm. above the foot-board, corresponding to 116 cm. when the patient has his shoes on. The distance between the back cushion and the foot-board is therefore 116 cm., which is the case when the foot-board is placed at No. 19 of the scale (135 — 116 = 19). The prescription will read thus : *Back cushion right, foot-board* 19. If the apparatus is used for the lumbar curve it is obvious that the corresponding prescription will read *Back cushion left, foot-board* 29.

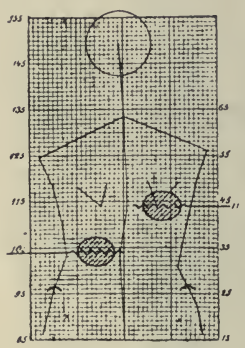

Fig. 165.

K4. Chair with inclined Seat.—The patient sits on a board which can be inclined at different angles and supports the side of his trunk against an adjustable side support. The apparatus is used for lumbar curves. One hip rests higher than the other, and the lumbar curve is thus pressed over to the opposite side. The patient must sit with the hip on the convex side higher than the other. The patient may maintain this corrected position for half to one hour, and even more, with advantage. This apparatus is most suitable for the patient to use at home ; more powerful methods are used in treatment by gymnastics.

K5. Sitting Side Pressure (Fig. 166).—This apparatus resembles two hands which grasp the trunk from behind, one on each side at different heights, and try, by pressure, to correct the curvatures of the spine. It is never used alone, but always in

combination with an active arm movement (A2), the object of which is partly to prevent a too great downward pressure on the spine by the weight of the arms, and partly to aid the correction which arm movements actively try to produce. The two pressure pads can be placed at different heights over the patient's sitting plane, and are placed so that they rest at the height of the maximum convexities. By pressing down the handle of the angular levers the pressure pads are pressed against the patient's sides, and the handle is fixed at a sufficient pressure. The patient then performs the prescribed active arm movements.

FIG. 166.

Fig. 167 is a diagram of the technique of K5. The lines representing the position of the pressure cushions indicate the height of pressure—on the right side 47, and on the left 33. As the patient is in sitting position it is here, as opposed to K1, K2, and K3, not the left side of the measurement diagram, but the scale of height on the right which has to be considered.

To render more marked the passive correction by special apparatus some general apparatus may also be used.

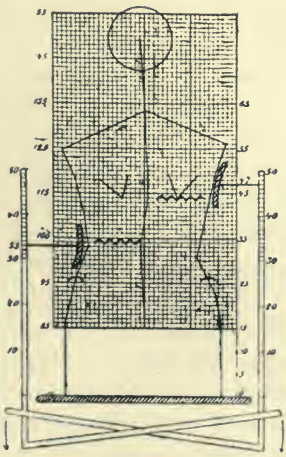

Fig. 167.

Thus, for example, *Trunk-balancing apparatus*, D1, D2, and D3 (p. 304), may produce, by means of powerful passive flexions of the spine in various directions, a general mobility of the spine, particularly in the lumbar region. The fact that these movements can be so taken that their effect is asymmetrical is another factor in their usefulness.

CHEST-EXPANSION, E6 (p. 305), has a powerfully corrective effect. If there is any prominence of the ribs the patient is placed more to one side of the seat, so that the back cushion, when moved forward, is specially pressed against the prominence

of the chest, and the effect is similar to that of K3, with this difference, that the corrective pressure is not constant, but rhythmical, and works only on the back.

Apparatus for Active Correction.

These exercises are given with the aid of the general apparatus from groups A, B, C, and also with the specially constructed apparatus of group L.

Amongst the groups A, B, C the most commonly used are the following :—

A2. Arm- and Shoulder-lifting.—This apparatus is as simple as possible in construction, consisting only of weights with handles, " clubs," to be grasped while various arm exercises are performed. The weights vary from $\frac{1}{2}$ to 5 kg. and are numbered from 1 to 10.

The club exercises mostly used in scoliosis treatment are three in number. They may either be taken in free standing position or with apparatus K5.

(1) *Double Arm-lifting with a club in each hand forward, upward, outward, downward.*—The movement is symmetrical, and aims at strengthening the muscles of the shoulders and spine.

(2) *Single (right or left) Arm-lifting-outward and -upward.*—The effect of this depends on the secondary static contraction of the muscles of the spine which is caused by one-sided weighted arm exercises, but this is dealt with in more detail in the description of A3.

(3) *Single Shoulder-lifting* as high as possible, and sinking to starting position, while the weighted arm hangs downward throughout the exercise. The other arm may be in wing position. The movement aims at strengthening the muscles of the shoulder-girdle. It is used in the treatment of uneven shoulder-blades and is given for the shoulder which is lower. It has also a secondary effect on the back muscles of the opposite side, like that of Single Arm-lifting, but weaker.

A3. Double Arm-flexion (Fig. 168).—The apparatus consists of a stand on which are two pulleys with ropes above the patient's head, one end of each rope ending in a handle, the other end fastened to a lever with movable weights in the angle on each side of the lower part of the apparatus. The levers are raised when the patient pulls the handles down, and thus give the intended resistance. The starting position is with the arms stretched straight upward ; the arms are then lowered till the hands are at the level of the shoulders, and then allow themselves to be drawn upward again during the negative phase of the movement.

The exercise can be given either for two arms or one. In the

first case it is used to strengthen the muscles of the arm and spine, and also for expansion of the chest; in the second instance the movement is asymmetrical, and its effect upon the spine depends upon secondary contraction.

In weighted Single Arm movements the static contractions are according to the following rule:—*In lifting* (A2) *the muscles of the trunk on the opposite side contract; in downdrawing* (A3) *the muscles on the same side contract.* The reason of this is obvious. The upright position is maintained, among other things, by equal contraction of the spinal muscles on either side. If one side of the body, as in A2, is burdened more than the other, the body tends to bend over to that side, and this is prevented by the increased contraction of the muscles of the spine and trunk on the opposite side. This increased contraction is the result of the necessity of fixing the vertebræ where those muscles originate which in turn give the scapula the support required for the performance of the arm movement. The opposite takes place when the arm is drawn downward against resistance, as in A3, and the muscles of the spine and abdomen on the same side contract or increase their contraction. On these facts is based the use of the above-mentioned arm exercises in scoliosis treatment. In right-sided curvature Left Arm-stretching-upward (A2) or Right Arm-downdrawing (A3) are used, and *vice versa.* They may also be combined. In this case the movement is performed as follows:—The left arm with an A2 club is held bent upward so that the club is close to the shoulder; the right arm grasps one handle of A3 and is held stretched upward. From this position the left arm is stretched upward, the right at the same time being drawn downward till the hand is at the level of the shoulder, after which both arms return to position.

Fig. 168.

A5 and A6. Double Arm-carrying-forward and -backward is used for the general strengthening of the muscles of the chest and back, the latter particularly in kyphosis.

B3. Hip-updrawing.—The working part of the apparatus is a stirrup resting on the instep, which the patient lifts by drawing his leg upward. In the treatment of scoliosis this apparatus is sometimes used for Single Hip-raising, when the leg working against resistance is kept straight the whole time, and the hip of the same side is raised as far as possible (compare Shoulder-lifting). The effect is analogous to that of A3, *i.e.*, it strengthens the muscles of the same side in the lumbar region, and can be used for lumbar curvature.

B4. Hip-downpressing is the converse of B3. The apparatus has a lever provided with a "tread-iron," which is pressed upward by the weight lever of a shunting mechanism. The patient places his foot on the tread-iron, and by pressing it down overcomes the resistance of the apparatus. In the treatment of scoliosis this apparatus is used for lowering one hip; the knee is kept extended the whole time while the hip is raised and lowered. The effect is analogous to that of A2, *i.e.*, it exercises the lumbar muscles of the opposite side, and is sometimes used for lumbar curvature.

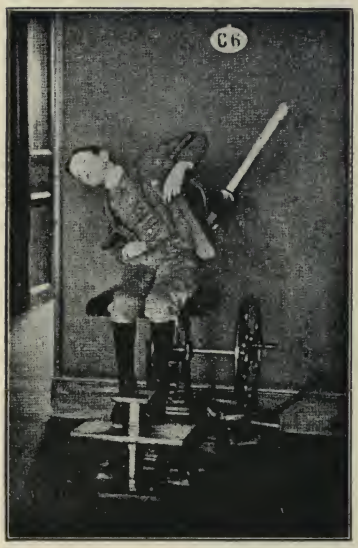

Fig. 169.

C5. Standing Trunk-raising (Fig. 150) (in Leg-lean-stoop-standing position).—The patient is put into a harness, which, with a strap running over a pulley, is fixed to the free end of the weight lever of the apparatus. By raising the trunk and bending it backward the patient lifts the weight lever, which gives the required resistance. The muscles of the back are strengthened, and the movement may sometimes be used in the treatment of scoliosis.

C6. Trunk-side-flexion (Fig. 169).—The apparatus has a padded curved back, against which the patient leans in sitting position, while he grasps its forward projecting end with his bent arms. The curved back moves round a sagittal axis and is connected, by means of a shunting mechanism, with a weight lever, which tries to turn the curved back to the right or left as required. The patient bends the trunk to the opposite side, thus raising the lever, which gives resistance, and then during the negative phase of the movement gives way to the pressure of the curved back and

returns to starting position. The muscles of one side are strengthened, and simultaneously the spine is flexed. It is used for C curvatures, of course towards the convex side of the curve.

C8. Pelvis-rotation (Fig. 170).—The patient sits on a stool which rotates round a vertical axis; his thighs are fixed to it by a cross-strap. The upper part of the body is fixed by the patient grasping with his arms a curved horizontal support for the back as in C6. In the vertical axis of the seat is a shunting mechanism with weight lever, which rotates the seat either to right or left according to the coupling of the screw. The movement has an active and a passive phase. In the passive phase the patient allows the apparatus to rotate his pelvis to one side, and in the active phase he turns as far as possible to the other side while the machine offers resistance. The movement is used either for both sides to increase the mobility of the spine and to strengthen the trunk muscles, or for one side when the shoulder girdle is rotated in reference to the pelvic girdle. In the latter case the exercise is given for one side only, so that those muscles only are exercised which bring the shoulders over the pelvis.

Fig. 170.

Fig. 171.

C10. Neck-raising, Head-side-flexion (Fig. 171).—The resistance for these different exercises is given by means of a "head-plate" with a handle placed against the head (neck, or one side). The plate is fastened with a rope which first runs horizontally and later bends over a pulley downward to the free end of a

weight lever. When the head is flexed in the direction above described the rope stretches and lifts the lever.

This movement is chiefly used for those neck muscles that are in action, *e.g.*, in Neck-raising for kyphosis. The secondary effect in this movement lies in the static contraction it causes in the back-muscles. In Head-side-flexion the muscles of the trunk on the same side work statically; in Neck-raising the muscles of the spine right down to the iliac crests of both sides (in standing position right down to the legs) also work statically. These secondary contractions may have either good or bad results in regard to the treatment, although in gymnastic therapy they either are of small practical importance or, as in kyphosis with lordosis, they may be directly harmful. In kyphosis the upper muscles of the back must be strengthened, but the secondary contractions of the muscles in the lumbar region are contra-indicated on account of lordosis. The advantage may be obtained without harm by choosing, not the standing position, but either a sitting position strongly-inclining-backward, or forward-leaning with suitable support. In both cases the secondary contractions in the lumbar region are prevented, since they then lose their *raison d'être*, which is to fix the trunk in regard to the pelvis.

We now have to deal with the apparatus constructed specially for scoliosis treatment.

C11. Lying Neck-raising and Head-side-flexion.—The apparatus is so constructed as to allow the above-mentioned head movements to be given in such a position that the secondary contractions of the lumbar muscles in Neck-raising and of the side muscles of the trunk in Head-side-flexion are excluded. The apparatus consists of a padded board, slanting almost as in K3, on which the patient lies either forward (in Neck-raising), supporting himself with his elbows as described and shown below in L7, or on one side (in Head-side-flexion). Resistance is given by means of a cushion placed at the back or side of the head, connected with a weighted lever under the reclining board.

L1. Combination of A3 and D1 (Fig. 172).—The apparatus is so arranged that the movement A3 can be taken in a sitting position. While in the above-mentioned apparatus the resistance is given by a weight fixed to a lever which is lifted by drawing down the arms, in L1 the weight is the patient himself, who sits on the board which is moved by the lever and pulls himself up. When the lever is raised the board slants sideways and raises the pelvis on one side. The exercise is thus a combination of active and passive correction. The active part is the arm movement, and the rules given in A3 hold here also; it may also be combined with A2, in

which the one arm (that of the convex side) performs an arm-downdrawing with one handle, while the other arm with an A2 club is stretched upward at the same time. The passive correction takes place in the lumbar region by means of the inclination of the pelvis. In left lumbar curves the patient must sit with his right side towards the pole where the axis of rotation of the lever is to be found. When the lever is raised the left side of the pelvis is lifted more than the right, whereby the lumbar region is pressed to the right, and simultaneously the arms draw the upper part of the body to the left. To increase the effect of the exercise on the lumbar curve a pressure cushion is placed on the patient's left side at the maximum point of the curve and fixed by a strap to a pair of uprights fixed to the lever close to its axis of rotation. When the lever rises the straps draw the cushion to the right, thus giving a corrective pressure in the lumbar region. This method of using L1 may be called "ordinary," when the movement is given in the "right" direction. There is also an "extra-ordinary" method, when the exercise is apparently given in the "wrong" direction, viz., when in a left lumbar curve the movement is given, not to the right, but to the left; the patient therefore sits turned to the opposite side. This method is used for a very low lumbar curve when the lower spinal region lies obliquely in regard to the sacrum, or, as we say, there is an "inclination" towards the pelvis. The angle of inclination to the pelvis on the convex side is acute and that on the concave side obtuse (an angle between a horizontal line drawn from the upper edge of the sacrum). To reach the lowest parts of this curve the patient must be so placed that the hip on the concave side is raised during the movement. In this case the side-pressure cushion, which would prevent this effect being obtained, is not used, but the arms are allowed to draw the body freely over in

Fig. 172.

the opposite direction. The spine is thus drawn to the right, while the pelvis is inclined to the left. An attempt is thus made to equalise the two angles, *i.e.*, to straighten out the angle of inclination between the pelvis and spine, and so to restore normal conditions.

L2 (Fig. 173) is not really an apparatus, but a support arrangement for some free active movements. It consists of two padded plinths, at the end of one of which is a foot support resembling the ancient " stocks," in which the feet are firmly fixed. The patient lies with his feet supported in the stocks, thus giving himself support for the various exercises, his trunk resting on the front plinth, which is lower. The most usual movements in this position are :—

Fig. 173.

Forward-lying Holding.—The patient is in Forward-lying position and raises the trunk just so much that it is horizontal.

Forward-lying Back-raising.—The trunk is raised from the above position still higher in an arch as far as it will go.

Right or Left-side-lying Holding.—The patient lies on either side and raises the trunk to a horizontal position.

Right or Left-side-lying Side-flexion.—From the position above described Side-flexion is given so that the trunk is flexed in an arch upward as far as possible.

Half (right or left)-side-lying Holding or Back-raising.—The patient lies half-way between Forward-lying and Side-lying, his thighs resting on a padded board placed obliquely on the plinth. The exercise is given either as a Holding or as a Back-raising.

Lying Trunk-raising.—The patient lies on his back and raises himself up to Sitting position.

During all these movements the arms are held in Hips-firm position, or in Neck-firm if the exercise is to be made stronger.

The different uses and effects of these various movements are as follows :—Forward-lying exercises are used for the symmetrical exercise of the spinal muscles, Forward-lying Holding when there is a risk of increasing lordosis by movement. Side-lying exercises are used for single curves, to strengthen the muscles on the convex

side. Half-side-lying exercises, especially Holdings, are used in double scoliosis to exercise the muscles on the convex side of the lumbar curve without affecting those of the dorsal curve, which could not be avoided in pure Side-lying Holding. Lying Trunk-raising strengthens the abdominal muscles.

L3. Pelvis-carrying to Side (Fig. 174).—The patient sits on a board like a little carriage which runs sideways on rails. To the carriage are fixed two straps running in both directions parallel to the rails, and then bending downward over a pair of pulleys, each supporting at its end a weight plate. To these plates are attached loose iron plates of different weights, by which means each plate is loaded and the carriage is drawn sideways. The upper part of the patient's body is fixed in the middle of the apparatus with side supports, which can be placed horizontally at different heights and widths, both of which are fixed under the arm-pits. When the patient grasps the handles of the side supports, the trunk is firmly fixed against the back and side supports. The patient sets the carriage in motion by moving the pelvis over to one side, at the same time drawing up the weight plates (from which the resistance is derived), and then allows the weight to draw the carriage back to starting position.

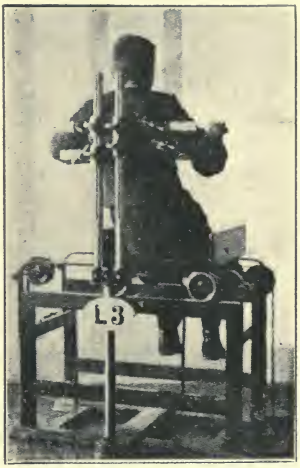

Fig. 174.

This movement is used in those cases of scoliosis in which the trunk leans over to one side of the pelvis. The muscles which come into exercise are those maintaining the upright position, *i.e.*, a correct position between the upper and lower part of the trunk. If the patient sits it does not matter if the trunk is corrected over the pelvis or *vice versa*. For reasons of construction the latter is the method used in this apparatus. If the upper part of the trunk leans over to the right, the left weight plate is loaded and draws the pelvis over to the left. During the movement the patient pushes his pelvis actively over to the right as far as possible—further than the mid-line of the upper part of the body, which is fixed—so as to strengthen those muscles which correct the faulty position.

The movement may also be used with advantage for dorsal curves without any trunk displacement. The upper part of the trunk is then fixed by means of the side supports right down to the

maximum point of the curve, and the movement aims at correcting the displacement between this point and the pelvis.

A few remarks may be made about the prescription of this movement. The vertical scales which mark the height of the side supports refer to the distance from their upper edge to the seat. The horizontal scales give the distance between these side supports and the centre of the apparatus. In writing the prescription one thus makes use of the height of the patient's sitting level in the diagram, and from this one arranges the position of the side supports to produce the required effect.

Figs. 175 and 176 explain the use of the apparatus in the above two cases. *a* denotes the side supports, *s* the sitting-board, *v* the weight

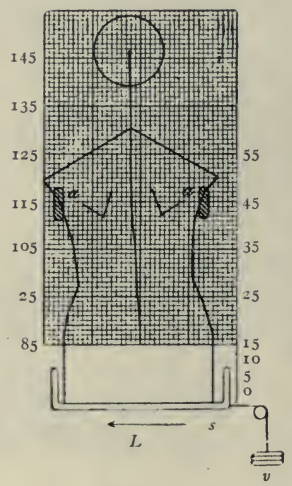

Fig. 175.

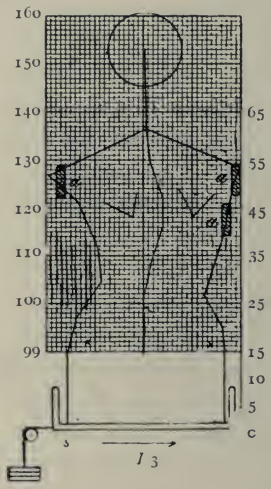

Fig. 176.

plate ; the arrow denotes the direction of the movement. As is seen in the first case, only two of the upper side supports are used. In the second case, where the upper part of the trunk must be fixed lower down, the lower side support is used, which is on the side of the dorsal convexity.

The prescription reads thus :—

For Fig. 175 :

$$\text{L3, left} \quad \frac{B\ 45 - 14}{0} \quad \text{No. 5 (weight)}$$

For Fig. 176 :

$$\text{L3, right} \quad \frac{B\ 54 - 17}{R\ 46 - 15} \quad \text{No. 8 (weight)}$$

In both formulæ the figures above the line denote the side supports and those below denote the lower ones. *B* means both sides ; *R* means right. The first figures denote the height above the stool, the last figures the distance from the mid-line.

L4. Pelvis-carrying-forward or -backward.—The apparatus consists of a chair gliding over a frame which stands on the floor. This frame can be adjusted on a slope forward or backward by the insertion of a block under the short end. The patient, seated in the chair, grasps a support placed at shoulder height. In moving forward the anterior part of the frame is raised and the patient draws himself up the incline, at the same time holding the arms stretched and rounding the back as much as possible. This exercise is used when there is lordosis. In the movement backward the back of the frame is raised, and the patient pushes himself backward, at the same time hollowing the back as much as possible. This exercise is used in flat back and lumbar kyphosis. Both exercises are difficult to perform accurately; the apparatus is therefore little used.

L5. Pelvis-side-tilting. — This apparatus consists of a stool which moves round a sagittal axis. Balance is maintained by a pendulum with a heavy weight attached to the seat. The patient sits fixed by a strap over the thighs, and by a pair of side supports projecting under the arms and fixed to the footboard. The movement is performed by the patient tilting the pelvis and sitting board down towards the side required. The exercise has a corrective effect by the lateral flexion which thus arises in the lumbar region, and by the asymmetric muscle action required for the movement.

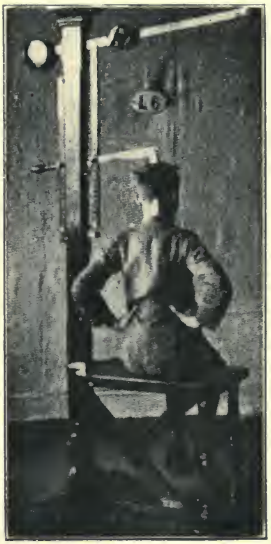

Fig. 177.

L6. Back-raising (Fig. 177). — The apparatus has a round cushion placed horizontally at the height of the head with a mechanism attached, which in turn is connected to a lever with a movable weight. The patient sits directly under the cushion, his head placed at such a height that it just touches when he is sitting with a very round back. The patient then straightens himself, pushing up the cushion as high as he can, and then returns to the starting position. The exercise strengthens all the extensor muscles of the spine.

L7. Lumbar-flexion (Fig. 178).—The patient lies prone on the apparatus (as in L2 Forward-lying Holding); the elbows are supported on the front plinth with the upper arm vertical. Transversely across the lumbar region between the iliac crests and the lower border of the thorax a hard rectangular cushion is placed,

attached, by means of a strap passing under the patient's abdomen towards the ground, to the free end of a weight lever. The position is taken by the patient holding his spine passively arched downward, as in a lordosis position. The patient then arches his spine upward (backward) as far as possible, like a cat, without moving the shoulders and hips, and then resumes the starting position. This movement has a direct effect in counteracting lordosis by strengthening those muscles which correct it.

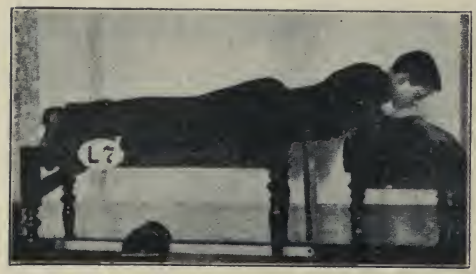

Fig. 178.

After this description of Dr. Zander's apparatus used for the treatment of scoliosis we may suitably end the chapter with examples of diagrams representing different types of scoliosis and the exercises suitable for their treatment arranged as an ordinary gymnastic prescription.

Anna.

K1. Right 122, 45°.
L3. Right No. 10 $\frac{B\ 54-17}{R\ 46-15}$
K5. Right 45; Left 25 (st.); A2. No. 3 Left out; Left over.

K3. 17; Back cushion R. c. 10; Chest cushion L20; Scale 148; No. 20.
L2. Half-right-side-lying Holding.
Running Back-hacking (G1).

K1. As above.
L3. „ „
L1. Right $\frac{50}{45}\cdot\frac{50}{-}$. Right down; Left stretch.

E6. Right.
C6. Right or L2 Left-side-lying Head-side-bending.
K5 and A2. As above.

K1.
L6. No. 8. Height 82.
J5.

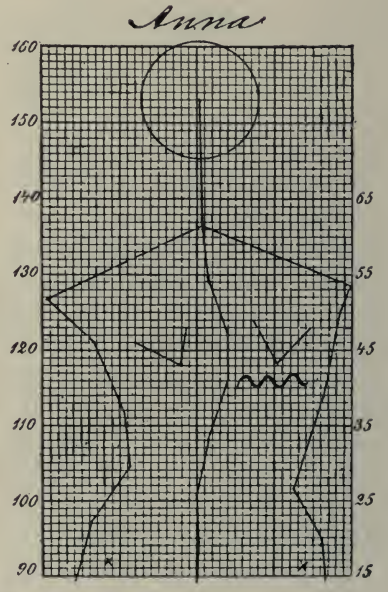

Fig. 179.

ELISABETH.

K1. Left 120, 45°.
C6. Left No. .
A3. Left No. 6 + A2; Right No. 4.
K3. 17; Back cushion Left c. 8; Chest cushion 0; Scale 144, No. 20.
L3. Left No. 10 $\frac{B\ 52-15}{L\ 43-12}$.
Running Back-hacking.
K2. Left $100+\frac{12}{12}$; Slope 20°.
L2. Right-side-lying Left side-bending.
K5. Right 48 (st.); Left 35. A2 No. 4 Right-shoulder-raising.
K1.
L3.
L1. Left $\frac{50\ .\ 50}{45}$ Hip-drawing.
E6. Left.
L6. No. 8. Height 82.
J5.

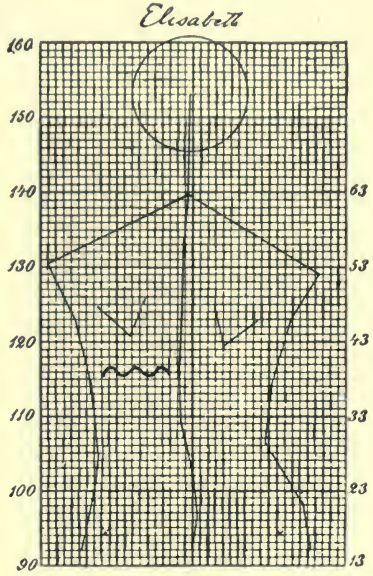

FIG. 180.

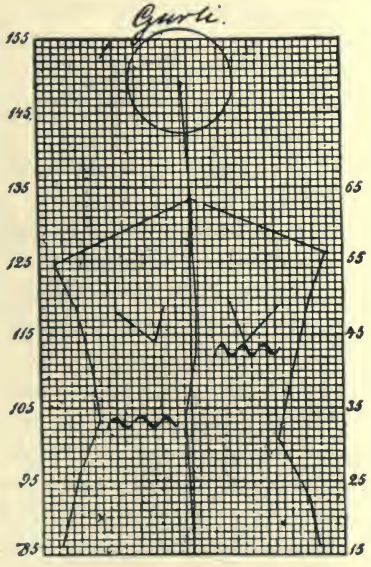

FIG. 181.

GURLI.

K1. Right 119, 45°.
L3. Right No. 8 $\frac{B\ 55-14}{H\ 48-11}$.
K5. Right 45; Left 34; A2 No. 3; Left out; Left over.
K3. 20; Back cushion Right c. 8; Chest cushion Left 16; Angle 144; No. 18.
L3.
(Running Back-hacking.)
K2. Left $95+\frac{10}{12}$.
L2. Half-right-side-ly. Holding.
L1. Right $\frac{50\ .\ 50}{45}$ Right down, Left stretch. Left Side-press. 32.
K3. 30; Back cushion Left c. 8; Chest cushion 0; Angle 134; No. 20.
C5. N5.
K5. + A2.
E6. Right.
L3.
J5.

CHAPTER XI.

THE USE OF MEDICAL GYMNASTICS AND MASSAGE IN ORTHOPÆDICS.

Torticollis—Scoliosis—Contractures of Joints—Paralytic Joint Deformities—Congenital Luxation of the Hip —Flat-Foot—Congenital Club-Foot.

By Patrik Haglund, M.D.

In orthopædics, the study of the deformities of the human body and their treatment, mechano-therapy plays a great part. And in reference to medical gymnastics and massage it is no exaggeration to say that very few orthopædic cases can be treated with the best results without the use of these forms of treatment. The orthopædist does well to make use of many other means for the correction or improvement of deformities, those which lie outside the region of mechano-therapeutics, as, for example, surgical operations, forced correction with or without narcosis, and subsequent fixation in plaster, as well as purely mechanical expedients such as fixation apparatus; but each of these methods of treatment is in most cases insufficient by itself if it is not combined with others, and with suitable gymnastic and massage treatment. On the other hand, it must be strongly emphasised that gymnastics and massage alone in orthopædic cases very seldom gain the object in view, viz., the greatest possible diminution of the deformity, or in the most fortunate cases its cure. In opposition to the gymnastic school which attaches too great importance to medical gymnastics and massage in connection with orthopædics, stress must be laid on the fact that these methods of treatment comparatively seldom form the chief factor in orthopædic treatment.

This fact, that it is only in combination with other expedients, surgical or non-surgical, that medical gymnastics and massage can accomplish anything in the treatment of orthopædic cases, limits their use in these, in contrast to their use in many other cases, such as the chronic rheumatic and many slighter affections, where medical gymnastics and massage are often quite sufficient to produce a *restitutio ad integrum*, or the greatest possible improvement. For this reason collaboration between the medical gymnast and the doctor is even more necessary in orthopædic gymnastics than it is in perhaps any other department of medicine, and inde-

pendent work on the part of the medical gymnast * is of very little use in these cases, and is even detrimental to the patient, since it often leads to the neglect of other methods of treatment which are frequently successful when used in combination with medical gymnastics and massage. The medical gymnast's collaboration with, or rather complete subordination to, the orthopædic specialist is therefore imperative for the sake of the patient.

There are other conditions peculiar to the medical gymnast's work in connection with orthopædics. Thus orthopædic treatment is often characterised by its long duration, which may be months or years, and the medical gymnast during this time takes part in quite different phases of treatment with quite different aims. At one time medical gymnastics and massage may be treatment preparatory to surgical handling, or again may serve as a necessary after-treatment to the same, or lastly may go on simultaneously with the no less important treatment by fixation apparatus. Sound knowledge of the various aims of orthopædic treatment and patience are therefore necessary for those who give medical gymnastics and massage in orthopædic cases, and the necessity for this last characteristic is all the greater since many of these cases are met with in children.

Further, it may be stated that the result in orthopædic cases seldom consists of a real *restitutio ad integrum*, but is generally only a greater or less improvement, which, however, may be of very great value to the patient. Many orthopædic cases may well be reckoned amongst the most hopeless, as the more severe cases of infantile paralysis and many others ; but such a remarkable improvement in the condition of these patients can often be produced by perseverance, and varied expert treatment, that it plays a very great part in the whole future of the unfortunate individual.

Another condition which distinguishes gymnastic and massage treatment used with an orthopædic aim is the relation between medical gymnastics—I mean by this exclusively the performance of movements used with a practical medical aim—and massage. In other branches of practical medicine among the various means of physical treatment the balance of power often lies with massage ; in orthopædics, on the contrary, the predominant *rôle* is played by gymnastics, especially in the form of muscle exercise. It must also be stated that in orthopædics medico-mechanical gymnastic apparatus play a great part, so great that the use of these for whole groups of orthopædic cases is indispensable to obtaining the best possible results, and in all cases their effect is much superior to that of manual medical gymnastics.

* *N.B.*—Persons untrained in medicine.

All these conditions which characterise the use of medical gymnastics and massage in orthopædics seem to supply a good reason why a chapter devoted specially to their use in orthopædics should find a place in a manual on medical gymnastics and massage. In orthopædic practice I so often find evidence of great ignorance concerning the commonest orthopædic cases and their treatment, not only among medical gymnasts, but among medical men, that I gladly acceded to the request of the author of this book to write a chapter on the subject. It is unavoidable that my work should touch on subjects already dealt with.

In such a chapter it is obvious that a detailed account cannot be given of all orthopædic cases in which medical gymnastics and massage play a part worth mentioning; space alone would forbid. Such a detailed description of the different deformities and their treatment belongs to the instruction of medical students in orthopædics; rational instruction in this by no means unimportant subject is unfortunately still lacking in our medical schools. The writer must confine himself to giving an account of the general aims of medical gymnastics in the treatment of deformities and the application of the general principles to certain of the largest and most important groups of deformities.

The somewhat indefinite term "deformity," the meaning of which is seldom defined in the same way in two different books, but which is now more generally limited to congenital or acquired faulty positions of the skeleton or organs of locomotion, denotes merely a deviation from the normal form, but since a pathological form in most cases accompanies a pathologically altered function, one can at least say from the standpoint of medical gymnastics and massage that the general aim in the treatment of orthopædic cases is to restore a faulty skeletal form, with all that pertains to it, to a normal form, as well as the accompanying abnormal function to a normal function. This expresses the whole existence and aim of orthopædics. The more one succeeds in restoring a deformity to normal form and function, the better is the result. But it is not enough to restore a deformed portion of the skeleton to its normal form; one must try to maintain the normal form, *i.e.*, to avoid recurrence. And it is all the more necessary to point this out, as in orthopædics, much more than in other special branches of medicine, one has to expect recurrences; most of the deformities which can be corrected have a remarkable tendency to recur, and in no cases is such a false estimate of the result of treatment formed as in these, when, as is too often the case, only the primary result of treatment is studied.

Every faulty position of the skeleton, and the parts of our

locomotor and supporting apparatus connected with it, must have a cause, and in their treatment, as in all other treatment, one must try to reach as far back as possible in the chain of causes and aim at its removal. In the study of different kinds of deformity one speedily finds that the fundamental causes cannot be reached by any of the therapeutic means at the command of practical medicine. To give a concrete example by way of illustration, one may here mention club-foot resulting from paralysis. In this, generally following an acute anterior poliomyelitis, the deformity and the faulty position depend on the disturbed equilibrium between the muscles, the result of the partial or total paralysis of certain muscles or muscle-groups; this paralysis again depends upon the destruction of certain motor cells in the anterior horn of the spinal cord, for which destruction naturally we can do nothing. Thus, if we succeed in one way or another in restoring the paralytic club-foot to its most normal form, the cause of the deformity remains. The deformity must recur, since the original cause persists, viz., the lost equilibrium between the muscles. This and similar conditions in most of the groups of deformities can scarcely be emphasised enough, inasmuch as a regrettable over-estimation of the results obtained flourishes in no other department of practical medicine as it does in so-called orthopædic gymnastics. To have restored a markedly deformed paralytic club-foot to its normal condition naturally at first appears to the ignorant a very brilliant result, and many gymnasts (*e.g.*, de Ron) have won great reputations by such cures. The value of the cure is greatly reduced in the eyes of those who understand clearly and distinctly that inevitable relapse can only be prevented by quite special measures, and often, unfortunately, not even by these.

The three chief indications for all orthopædic treatment are to try (1) by prophylaxis to prevent or counteract the appearance of deformity, (2) to restore to normal form and function any alteration in form and function which is already present, and (3) to maintain the restored or improved form and function. My aim in the following special sections will be to state shortly to what extent medical gymnastics and massage play a part in the fulfilment of these different indications. If I cannot mention here all the deformities which may be found, I may nevertheless be able, in connection with the treatment of selected deformities, to state the most important points of view, by the application of which the medical gymnast should be able to carry out the treatment of the various deformities which are not mentioned.

Before I go on to discuss the importance of medical gymnastics and massage in the treatment of the most common and typical

deformities I will first say a few words on the relationship of manual and mechanical treatment in the field of orthopædics. While, as already stated, in many other departments of medicine, and especially in the case of diseased conditions in the treatment of which massage plays a considerable part, the purely manual treatment, massage given without apparatus and the so-called Ling medical gymnastics, surpasses the medico-mechanical with machines and other apparatus; this is by no means the case in reference to orthopædics. Just as the orthopædist, who has completely at his command all the therapeutic resources of orthopædics (operation, the technique of plaster and bandaging, gymnastics and massage, etc.), without doubt obtains the best results; the same is true of the medical gymnast's work in orthopædics. The more numerous and varied means he has at his command the better are his results. And one may say without exaggeration that in the treatment of whole groups of orthopædic cases the gymnast is somewhat stranded unless he has access to, and understands how to use, mechanical gymnastic apparatus. And it is in orthopædics that the medico-mechanical gymnastics invented in Sweden (by Zander) have attained their greatest importance in other lands. A very large number of gymnastic apparatus specially constructed for orthopædic purposes have been invented and are used almost everywhere. Entire systems of medico-mechanical gymnastic apparatus have been constructed in recent times which, in the collections of apparatus of the large medico-mechanical institutes, compete in fundamentals with the original apparatus of Zander, on which they are founded, without, so far as I understand, having yet excelled them for general gymnastic purposes and heart cases. On the other hand, it must be said that quite outside the limits of the Zander system, and even before it in point of time, many mechanical apparatus of great use in orthopædics had appeared. One must specially mention many correcting and holding apparatus for the treatment of scoliosis, from the simplest, which can be arranged and used without difficulty by the general practitioner, to the most complicated and expensive, which can scarcely be used except in the great orthopædic institutes. Above all must be mentioned the Krukenberg pendulum apparatus for all kinds of joint mobilisation. Owing to the excellence of the fundamental idea, and the practical way in which it is carried out for its special aim, it has come in an inconceivably short time to be regarded as almost indispensable in orthopædics, and is used throughout the whole civilised world.

The great and undeniable importance of mechanical apparatus and machines in orthopædics in no way detracts from the import-

ance of the purely manual treatment. Massage of course plays a great part, and this, except in the varieties of tapôtement, can never be quite satisfactorily given by mechanical means; orthopædic cases, moreover, must often be treated in conditions where mechanical gymnastic resources are not applicable or available. Manual treatment for an orthopædic case can, moreover, be managed in any place where a good medical gymnast is at work, while mechanical gymnastic treatment can only be obtained in places where orthopædic establishments or medico-mechanical gymnastic institutes are to be found. Further, the orthopædist has often to work with small children who have not reached the age of six or ten, before which age medico-mechanical gymnastics cannot be used with any great advantage. Lastly, and above all, one must mention once more that both means used together give better results than one used alone. One sees nowadays in orthopædic departments abroad, private or public, mechanical and manual gymnastic resources used together in daily closer combination. It is reserved for *Sweden*, the so-called motherland of both these gymnastic systems, to maintain a curious separation between two gymnastic systems each of itself well justified and together extremely effective, a separation which certainly hampers the development of medical gymnastics.

In the following more special account of the use of medical gymnastics and massage in orthopædic cases, for reasons already given, only a few types of deformity are described. These have been so chosen that deformities of the spine and trunk as well as of the extremities have been represented, and that in the treatment of the types chosen all the most important points of view are put forward to enable the medical gymnast to arrange his treatment of the many-sided orthopædic cases in their varied phases so that it shall be as effective and beneficial as possible. The weight of choice has fallen on the purely orthopædic side, while the large border region which orthopædics shares with surgery, the treatment of joint inflammations and of bone and joint injuries, has been omitted, since the physical treatment of these conditions has been described in detail in another part of this book.

A. Deformities of the Spine.

I. Torticollis.

Torticollis, or *Caput obstipum* (the permanent crooked position of the head, which consists of bending of the head to one side, rotation to the opposite side, with the chin raised and the back of the head lowered, corresponding to the action of the sterno-cleido-

mastoid muscle of one side), occurs in two essentially different forms from the point of view of medical gymnastics and massage.

In one form, which is generally found as truly congenital or acquired during birth, the head is somewhat fixed in the above faulty position, with the power of only slight movement from its faulty resting position. The latter depends in most cases on changes in the muscles, which are by degrees associated with corresponding shrinkings and tightenings of ligaments as well as changes in shape of cartilage and bone, as is always the case with deformities produced by changes in muscles.

The muscular change consists of a permanent shortening of the sterno-cleido-mastoid muscle of one side; this may have arisen during fœtal life owing to faulty position of the fœtus as a so-called intra-uterine deformity due to gravity, in which case the ligaments and bony parts will have undergone corresponding changes of shape during the growth of the fœtus, or during birth by rupture or other severe injury, with consequent shrinking of the sterno-cleido-mastoid muscle of one side. This explanation of torticollis, which was formerly accepted, cannot be so often valid as was generally stated; on the contrary, this mode of origin must be uncommon, as everyday experience teaches us that a ruptured muscle in healing becomes longer, not shorter. A similar faulty position of the head may also arise as necessary compensation to a severe scoliosis, or as a habit deformity in people with strabismus, who can only avoid troublesome double images by some such position of the head. A similar position arises as a paralytic deformity in unilateral paralysis of neck muscles. Further, this deformity may arise by contracture of other soft parts, as of scar tissue after burns or other severe injuries.

The other form of torticollis is that most often met with in adult patients, the spasmodic form, caused by clonic cramp in the sterno-cleido-mastoid muscle of one or sometimes both sides, generally combined with cramp in the upper part of trapezius and other muscles supplied by the upper cervical nerve roots.

The indications for treatment are essentially different in these different forms. In that form commonly met with in children, the ordinary torticollis, the faulty position must be corrected, which cannot generally be done without operation under an anæsthetic. The shortened sterno-mastoid may be divided, or partly or wholly removed along with other soft parts. In certain cases, especially when the patient is treated quite early, it should be possible to restore the head to its normal position by manual correction alone with suitable bandages; this, however, seldom or never takes place in practice, so that medical gymnastic treatment

as a rule is not begun till the surgical treatment is ended. After correction or a certain degree of over-correction has been obtained by means of one or other operation a fixation apparatus is applied. If this can be easily taken off the medical gymnastic treatment is begun a few days after the operation, in other cases, three or four weeks after the operation, as soon as the apparatus is removed. The treatment consists of correcting movements towards the side opposite to that of the original faulty position, and of exercising the sterno-cleido-mastoid of the opposite side. One-sided head movements are therefore given, and, after the action of the sterno-cleido-mastoid of the healthy side has been developed to its greatest extent, symmetrical movements are practised, till the head movements have become in all respects as normal as possible. This methodical exercise of the healthy, unshortened, and pathologically unchanged muscle is a very important factor, and this naturally holds good not only for the treatment of torticollis, but of all muscle contractures. It may therefore be well to speak here in greater detail of this condition. One might suppose that when the action of a contracted muscle and hence the hindrance to the working of its antagonists have been removed, these muscles would at once begin to exert their effect on the joint concerned, and the patient would himself by degrees exercise the power of performing the corresponding movements, hitherto impossible owing to the contracture. Medical gymnastic treatment ought therefore to be unnecessary. This, however, is by no means the case, since the antagonists of a contracted muscle also undergo changes. On the one hand they atrophy owing to disuse, and this atrophy may be so great that the effect of contraction of the muscle is almost *nil ;* on the other hand, the patient has by degrees lost the habit of voluntary impulses, having found for a long time that they did not produce the desired effect, and has thereby lost what might be called the functional connection between the will and the function of the muscle in question. The working power of such muscles, which has thus been lost or reduced to a minimum, is more surely and quickly restored by means of methodical exercise than without it. Further, one must lay great stress on a specially important factor, which is that normal mobility is not easily restored after correction of a contracture. The permanent faulty position due to shortening of muscle often oversteps the limit of flexion used in ordinary movement, and for this reason the antagonists are often considerably lengthened. Since in general a muscle in contraction cannot shorten more than a certain proportion of its length, the fact must also be considered that, even if a lengthened muscle contracts, its effect on the corresponding portion

of the skeleton is unsatisfactory. With continued exercise a muscle should by degrees recover a medium length, and possibly also the power to contract to a greater proportion of its total length than formerly. The medical gymnastic exercise of muscles after correction of a contracture is therefore a very important part of treatment, without which the latter seldom leads to the desired result. In connection with this question it must be added that sometimes even the most energetic gymnastics fail to restore the muscles to effective function. The orthopædist must then have recourse to extreme operative measures, such as shortening of muscle or tendon, as preparatory operations to treatment by exercise. Thus, in severe cases of torticollis, by a preliminary shortening of the lengthened muscle of the healthy side satisfactory function has been restored to it, without which the result of a torticollis treatment cannot be satisfactory. We may state the following as a quite general rule : Exercise by gymnastics must be used as after-treatment in every case in which one has by orthopædic operation, cutting or otherwise, changed the position of contracture of a joint, however caused. As orthopædic interference is generally of this kind, one can easily understand how indispensable medical gymnastic treatment really is in this special branch of medicine.

Concerning the special technique of the after-treatment of this form of torticollis one need not speak here ; every medical gymnast, who understands the indication for treatment in each special case, easily finds the movements that are necessary ; the technique of medical gymnastics is, moreover, dealt with elsewhere in this book. Neither can it be necessary in what follows to mention in each case the great importance of massage for the stretching of contracted soft parts, restoration of healthy circulation, removal of exudations and hæmorrhages into the tissues which are often to be found after orthopædic treatment, etc. These are matters involved in the general use and importance of massage, and are discussed in detail in another part of the book. Although somewhat outside the subject, one may here mention that in the after-treatment in question faradisation of the muscles is often used along with treatment by gymnastic exercises. The value of this simple remedy is again receiving recognition, after a period of neglect due to reaction against the reckless over-estimation of the value of electricity, which followed its introduction into therapeutics.

The other chief variety of torticollis, the clonic, spastic form, or, as it is often called, " accessorius cramp," which is generally met with in adults, is an affection much harder to cure. As in the case of many other forms of clonic cramp, the varied operative

treatment which has been proposed and made use of in these cases, from simple division of single muscles, tendons, and nerves to the more extensive resection of whole muscles, nerves and nerve plexuses, has been on the whole very unsatisfactory, and in too many cases devoid of result. Severe cases of clonic torticollis have rightly been reckoned amongst the most hopeless pathological conditions. Since they may also be reckoned among the affections most painful and depressing to patients, and frequently compel recourse to serious operations which are not without risk, one welcomes all the more gladly the experience in recent times of the use of gymnastics alone in this affection. Even in very severe cases good results have been obtained by such treatment, and it is at the present time ordered even by surgeons.

The medical gymnastic treatment, which in these cases plays a somewhat large part, is purely treatment by *exercise*, and does not consist of mechanical methods applied to peripheral parts, but more, as in educational gymnastics, of methodical, central, *i.e.*, voluntary exercises. Since it is a fact that operative methods, which have by degrees been carried higher and higher up the motor path towards the centre, but never reach higher than the cervical roots, have often proved to be failures, and since it is also a well-known fact that these cramps are generally influenced to a great extent by psychical causes, one has every reason to assume that the cause of these cramps is to be sought in the psychic centres. The medical gymnastic treatment of this condition starts with the assumption that exercise of the centres is the aim in view. The technique of the treatment is therefore in some ways that of *educational* gymnastics. The patient must under direction and supervision practise control of the jerking movements, and also practise fully controlled and co-ordinated symmetrical movements. If the affection has been of long duration and has already produced a certain degree of permanent faulty position, corrective movements are of course suitable ; they must, however, be performed with great caution, since experience shows that they may greatly increase the painful jerkings ; for a similar reason resistance is not given, or at least very little, in the performance of exercises. In regard to the technique, it is worth remembering that in these cases, as in all other therapeutic exercises for cramps, ataxy and the like, it is very useful to let the patient practise before a looking-glass. By studying his movements in a looking-glass the patient often learns much more quickly to control them, *i.e.*, to repress the involuntary and to perform the voluntary muscular contractions, than by ordinary gymnastic exercises done to command. It is

stated—and quite recently the statement has come from a distinguished surgical source (Professor John Berg amongst others)—that by such a procedure good results have sometimes been obtained even in very severe cases, and that the result has often been obtained wonderfully quickly.

II. Other Deformities of the Spine.

Concerning the treatment of the various scolioses and kyphoses by massage and gymnastics I may here speak quite briefly. The great importance—in certain cases the paramount importance—of medical gymnastics in the treatment of these deformities is generally known and recognised by doctors, gymnasts and others, and the technique of both manual and mechanical gymnastics used in the treatment of the deformities belonging to this large group is so well developed that very little can be added from the special standpoint of the orthopædist to what has been already stated elsewhere in this work (Arvedson, Zander). Nevertheless some indications from the special orthopædist's standpoint of the general principles of treatment of scoliosis and other deformities are not out of place here.

In contemplating the great difficulties which are met with in the treatment of marked scoliosis and the consequently slight results usually obtained, even after long-continued and energetic treatment, we must consider that prophylaxis is the most important point of attack against it. Pure prophylaxis against these deformities belongs more to school and general hygiene and the bringing up of children than to medical gymnastics, and must therefore be left on one side. We may be reminded how enlightened schoolmasters, doctors, and gymnasts have tried during the last half-century by improved school furniture, school premises, and schemes of instruction, to prevent habitual forms of scoliosis arising, and how in improving the standard of physical development (by gymnastics, sport, games) we find more and more a means of counteracting this as well as many other conditions of ill-health directly or indirectly produced by one-sided systems of upbringing under unsuitable conditions. Progress in this direction is beyond dispute, although it will be many decades before we can truly interpret the results. In any case, marked scoliosis arises in so many cases that we have reason to consider how we can make use of medical gymnastics according to the above-stated indications for the treatment of all deformities.

When a spinal curvature has actually developed, the primary aim of treatment is to restore the pathologically curved spine to its

normal form, which is without lateral curves and with the ordinary physiological curves in the sagittal plane.

This aim meets with several serious difficulties, depending upon the degree and general characteristics of the curve. Momentary restoration to normal is of no great difficulty in scolioses which have not yet become fixed, and the patient himself after some expert instruction can accomplish this by greater or less strain of his muscles of deportment. In the higher degrees of deformity difficulties accumulate in quick succession. All the parts belonging to the spine and its functions undergo changes due to the permanent faulty position; these by degrees become permanent, and more and more insurmountable by the power of the muscles alone. Thus joint capsules, ligaments, and muscles contract on the concave side and become stretched on the convex. Finally, in every true scoliosis the vertebræ, with their arches, processes and joint surfaces, undergo considerable changes of form, while as the last and worst step in a progressive case, the form of the ribs and their situation relatively to each other become altered, so that severe deformities arise.

So long as the pathological changes only affect the soft parts and the skeleton has not yet undergone obvious changes of form, the above-mentioned chief indication can be fulfilled, although sometimes only with great difficulty, by the help of physical treatment which lies at the disposal of practical medicine. If the skeleton has, on the other hand, undergone great changes of form, we cannot attain the primary object, at least not directly, by the use of external mechano-therapeutic means.

If we examine closely the expedients of mechano-therapeutics, by which we can at least temporarily restore the spine to its normal form, or, in a word, correct it, we find different groups of expedients.

Thus we find in the Ling medical gymnastic system a great number of movements, in most cases very rational, carefully thought out, and adapted to the treatment of spinal deformities. In the use of these simple gymnastic movements one gymnastic school sees the sovereign means of treatment for all scolioses, and is of opinion that these Ling gymnastic movements, which can be used everywhere and without any considerable apparatus, are quite sufficient to obtain all that can be obtained in the treatment of these deformities. This idea is quite incorrect. It is no doubt true that the slight scolioses in school children, who form the greater number of the cases treated in our Swedish gymnastic institutions, can be affected by exclusively manual correction and active muscular exercises with only manual resistance, and will show great progress in their earlier stages. By examining our

resources and the actual purpose of the treatment we soon find that in severe cases of scoliosis these means are not so effective as gymnastic enthusiasts would willingly believe.

It is by the combination of two chief means that we try to influence a spinal curvature in order to restore it to normal form. On the one hand, we can make use of external means for the correction of deformity in the form of external pressure, so applied that it can correct the deformity ; on the other hand, we can take the patient's own muscles into use to produce correction with their help. In Ling gymnastics the external effect is produced by the manual pressure of the medical gymnast, and the resistance necessary in the active muscular exercises is given manually. If this direct, immediate human force were sufficient under all circumstances, the Ling medical gymnastic system would be enough for the treatment of all scoliosis, at least in so far as it aims at restoring the spine to its normal form. Further, this manual method of treatment should certainly eclipse every other system of treatment for scoliosis, since it has the advantage that movements as well as pressure and resistance can be individualised to an almost unlimited extent ; and, as very little apparatus is needed for its performance, it can be carried out anywhere, not necessarily in expensive institutions for the purpose.

The strength of the medical gymnast is, moreover, by no means sufficient. High degrees of scoliosis with definite changes in the soft parts and bones require much greater force for their effective correction. This is true not so much of the momentary force, which can certainly be exercised in sufficient strength manually, but of its staying power. A little reflection indicates that a correcting movement for scoliosis, if it is to have some effect, must be given for a much longer time than purely manual medical gymnastics allows. In scoliosis between the medical gymnastic *séances* every force tends to send it back to its ordinary degree, or rather to increase it ; in these circumstances it is almost incredible that a passive correction performed for a very short time should play any noteworthy curative part. It has some importance in mobilising fixed scolioses ; but even here greater force is often necessary.

On the other hand, this first indication, restoration to normal form, can be fulfilled in a much more effective way by using mechanical apparatus and machines. In the last few decades a great variety of corrective apparatus for the treatment of scoliosis has appeared, from the simplest and most primitive, which can be put together with easily-obtained material by any doctor, to the most complicated and expensive mechanical apparatus, which are

only to be found in special institutions. By means of these apparatus, arranged for pressure at the ordinary points of application on the thorax and pelvis, and provided with mechanical arrangements so that the point of application as well as the force used can be individualised according to the existing condition almost as much as in the manual corrective movements, the time of correction can be increased according to need. And in this gymnastic exercise scheme for scoliosis, which one sees carried out in large orthopædic institutes abroad, which scheme may occupy up to eight hours' gymnastic treatment in all every day, the greatest part of this time is devoted to correction in more or less complicated apparatus. The correction takes place in different positions, as lying, sitting, hanging, the inclined plane, etc. With such a corrective treatment it is clear that one can produce a greater effect than by manual correction in one or two Ling gymnastic *séances* daily; in severe cases the treatment is completed by a bed so constructed that a certain degree of correction takes place even at night.

In using the patient's own muscles to produce correction one may use purely active movements, pure self-corrective exercises. Some of these are to be found in the Ling system of gymnastics (*e.g.*, Spring-sitting Holding, etc.), besides which whole systems have been developed by gymnasts in Germany, and every interested gymnast can think out for a special case specially suitable home exercises. These exercises, which can be done without the simplest apparatus, are specially of importance in those cases in which the patient possesses enough energy to work himself for the correction of his deformity. Such patients are, however, few and far between, as every one who treats scoliosis finds by experience. To make this active correction with the help of the patient's own muscles more effective one gives resistance in all scoliosis movements. It is quite evident that a strong and skilful gymnast can exert with his hands a suitable resistance to active movements which serve to correct and over-correct a scoliosis. It is to be noted, however, that trunk movements require specially strong resistance, and that it is technically much harder to give manual resistance firmly and continuously enough in these than in extremity movements. Experience shows, too, that the gymnast is specially apt to tire in scoliosis treatment, so that the treatment becomes by degrees less energetic. For these reasons I am almost inclined in this form of scoliosis treatment to assign a higher merit to machines than to the Ling gymnastics. In the Zander collection of apparatus we find a whole group of active apparatus bearing upon scoliosis exercises; and outside the Zander system of apparatus, and indeed before it,

many kinds of useful and effective apparatus were constructed and used for this special orthopædic purpose.

The sum total of the foregoing criticism seems to me to be that one can seldom, as has been and is so often done in our own country, recommend the exclusively manual Ling scoliosis gymnastics as the ordinary method for all scoliosis treatment. Its great value, however, cannot be denied in the treatment of young school children with early discovered lateral deviations of slight degree. On the contrary, the manual treatment of these cases, so often practised in our Swedish institutes, cases so slight that their treatment borders on prophylactic therapy, has certainly a very great value as prophylaxis against the development of more severe forms of habitual scoliosis, and my opinion is that the reason we have such a small percentage of severe scoliosis in Sweden is because we treat girls with curvature as early as we do by Ling gymnastics. To mobilise and correct marked cases of scoliosis with a definite degree of fixation mechanical arrangements are, however, absolutely indispensable.

The more strongly and continuously the treatment by all these means is continued the better is the result. Of what nature are the results when one has tried by all these means to mobilise, correct and over-correct, as much as the conditions allow? In slight cases, the so-called first degree of scoliosis, and in the slighter cases of the second degree, the result may be good enough; in all the more severe cases one must, however, allow that progress, even with the most energetic and varied treatment, is unsatisfactory. One can assert, broadly speaking, in spite of the arduous work of decades on this subject, that scoliosis treatment still rests at about the same stage as was reported in 1880 by an official English Commission during the heated discussion on scoliosis of that time. The point to determine was which of the two methods of scoliosis treatment (which at that time were sharply opposed to each other), treatment by spinal jackets or by gymnastics, gave the best results. The Commission came to the conclusion that in slight cases something could well be gained by either method, but that in severe cases the aim was attained by neither. If any improvement in the results has been obtained since that time—many statements in the form of reports from different countries to the first International Congress on Physical Therapy held at Liége point to a somewhat less pessimistic opinion nowadays—it depends, beyond a doubt, on the fact that medico-mechanical gymnastics has become more and more known and used by those who treat scoliosis. All who do so should render homage to one of its greatest exponents, Gustaf Zander, who systematised medico-mechanical gymnastics.

If the immediate results of even the most energetic scoliosis gymnastics are not too brilliant in a bad case, it is all the more important to find means to maintain the result attained. With the knowledge we possess of the nature of scoliosis, we must take for granted that it will have a great tendency to recur as soon as it is left without this treatment. Such is the case, and the existing results of scoliosis treatment are in reality by no means so good as the reports from different orthopædic institutions state. These statements refer to the patient's condition at the end of the treatment, before the tendency to relapse or for the improvement to diminish has asserted itself. The following may be stated concerning the means we possess of maintaining the result.

While scarcely anyone denies the sovereignty of medical gymnastics (in its widest sense) in the treatment of scoliosis, in so far as it aims at mobilisation and correction, the means of maintaining the result have, on the other hand, been much disputed.

Since one rightly assigns to gymnastics which aims at development of muscle the greatest importance in mobilisation and correction, one must also assign to the trained muscles a great power of maintaining the result obtained by energetic gymnastic treatment of scoliosis; and the gymnastic enthusiast is ready to declare that the muscles after a well-carried out course of gymnastics are in such a condition that often a relapse need not occur. If this belief is sanguine, it is certainly obvious that continued gymnastic treatment is the best means of maintaining the result attained. Unfortunately for most people, insurmountable practical difficulties arise in continuing expensive gymnastic treatment for long periods, and the purely active self-correcting exercises which are learnt during a long treatment are seldom carried out energetically enough after the patient is left to himself. Other means of maintaining the result attained have therefore been sought. This brings us to the orthopædic supporting apparatus—spinal jackets for scoliosis. Although the use of spinal jackets, as of all other orthopædic apparatus, to be effective, must be directed by qualified medical practitioners, a few words on this important question may be appropriate here.

The idea of keeping upright, by means of a supporting apparatus, a spine or chest which threatens to sink together is, of course, very old, and the need for the method in certain forms of scoliosis, such as the paralytic, severe rachitic, etc., is quite clear. The wearing of a mechanical apparatus has in such cases been the only means of making the patient's life endurable. Although spinal jackets are in certain cases necessary and have for long been used, they have

nevertheless certain great inconveniences, however well they may be made and planned. Although this is not the place to speak of the construction of spinal jackets, it may here be mentioned that the making of these supports has recently greatly improved, whereby the inconveniences have to some extent been diminished and the effectiveness increased. However well constructed a spinal jacket may be, there remain certain definite inconveniences, such as the difficulty of wearing a heavy apparatus, the difficulty of making it fit, and, more than all, the fact that a spinal jacket puts out of action a certain number of muscles, with the result that the muscles atrophy. Over-estimation of these drawbacks on the one hand has led to the total disuse of jackets in all forms of scoliosis except the paralytic, in which, of course, the indication for a jacket is absolute; the under-estimation of these drawbacks combined with over-estimation of the power of the jacket really to support the spine has, on the other hand, led to their too frequent use.

Towards the end of last century the treatment by spinal jackets assumed an entirely new position. About the year 1880 Sayre's treatment by plaster jackets came into general use, and one saw with great surprise how patients could walk about without the slightest difficulty and feel quite well, wearing a plaster jacket which encircled the thorax and pelvis, sometimes even the shoulders and neck. In these circumstances it was only too natural to attempt to maintain by means of such a jacket the correction of a scoliosis obtained by energetic (or even violent) treatment. At the same time the study of functional adaptation had begun and its special reference to the study of the skeleton, the so-called Wolffian *law of structural change*, according to which a bone with altered function takes on changes of form more suited to its new functions. According to this theory, which is of extreme importance to the whole of modern orthopædics, it was argued that if one can by external means keep the spine and thorax for a considerable time in a corrected position the deformed bones, as well as the soft parts functionally connected with them, will undergo changes and by degrees approach more and more to the normal. The means of maintaining the correction was the spinal jacket, especially the fixed plaster jacket which could not be taken off. This was therefore brought into use in the treatment of scoliosis with a purely curative aim, and not only as a necessity in severe cases where complete sinking together threatened. Since many of those who treat scoliosis opposed the jacket treatment from the beginning as involving certain risks, from this time and for nearly twenty years after, orthopædists may be divided into two classes: those who pinned their faith to jackets and the gymnastic enthusiasts who

opposed this treatment. The upholders of the jacket treatment do not necessarily exclude gymnastics from their treatment, since it is impossible to do so, but they make use of jackets to a very large extent along with gymnastic treatment.

From the study of functional adaptation which was beginning to manifest its utility in connection with orthopædies, the adherents of the treatment by spinal jackets considered that the usual treatment of a marked scoliosis should consist of mobilisation and correction, for the attainment of which some forms of medical gymnastics were indispensable, followed by fixation for a reasonable time in the corrected position. The forces of nature would then inevitably restore the deformed parts, bones as well as soft parts, to their normal form. It ought to be possible to cure even a severe scoliosis in this way.

The opponents of the fixation treatment, on the other hand, feared the muscular atrophy which was bound to follow such long-continued fixation, and they considered that in practice they had found that such fixation is most often injurious—that it more often aggravates than improves a case of scoliosis.

Now after two or three decades we can begin to criticise the situation, and strenuous work in many well-equipped orthopædic institutions of various countries has done much to elucidate this difficult question. One sees at once that the great hopes entertained, more especially by those orthopædists most interested in biology, have by no means been fulfilled. This, of course, does not mean that the biological theories which lay at the root of the fixation treatment were wrong, but depends on other conditions. It is partly due to the fact that the chest, which is the chief point of fixation for all apparatus aiming at fixation of the spine in a certain position, cannot, with its movable and changeable contents, be fixed in the same sense as part of a leg or arm can be fixed by a plaster bandage. It is also partly due to the same fault having been made in the application of the theory to the treatment of scoliosis that was made in reference to the treatment of several other deformities by static means according to Wolff's law. It was forgotten that the form of any part of the skeleton is not due merely to physical forces, but that its function is always many-sided—*e.g.*, in reference to the spine it is not only to carry weight. It was overlooked that the part the muscles play in the normal functions of any part of the skeleton is at least as important in the production, development, and maintenance of its normal form as the normal functions are in reference to the force of gravity. It cannot possibly be good treatment to exclude the action of the muscles.

The gymnastic enthusiasts, or more correctly the opponents of the fixation treatment, have therefore by degrees been justified in their view that the drawbacks to the fixation method are so great that the latter cannot in any way be considered suitable routine treatment for all marked scoliosis. This does not imply that the spinal jacket has been permanently banished from spinal treatment; far from it. The adherents of the fixation method of treatment have done much good; various kinds of removable spinal jackets have been produced which are almost as effective as the fixed plaster jacket, and which, since they can be taken off, are no hindrance to the most energetic use of gymnastic treatment. The greatest drawback to the treatment by spinal jackets is therefore almost removed. Thus we have by degrees come to the usual conclusion, after such a struggle, that neither of the two extreme views can be held in the long run, and we find that in the treatment of scoliosis, as of everything else, we attain the best results by using all the means at our disposal. Certain as it is that the fixation treatment carried to excess is unsuitable for the treatment of the slighter forms of scoliosis, it is equally certain that the intelligent use of a well-constructed spinal jacket which can be taken off makes the treatment of the more severe forms more successful and renders the result more permanent.

The position of medical gymnastics in the treatment of scoliosis may, in my opinion, be summarised as follows :—

Medical gymnastic treatment begun as early as possible on the first indications of lateral deviation of the spine certainly prevents the development of the more severe forms in almost all cases. In the case of small school children (about the age of ten or twelve) Ling's medical gymnastics should be sufficient. For older patients and in all cases of well-marked scoliosis one must have recourse to the most energetic and continuous medical gymnastics combined with the use of corrective apparatus, or of apparatus in which the patient lies in a corrected position. Further, such treatment must inevitably be used along with and alternating with the treatment by spinal jackets, which ought to be used in some—relatively few—cases.

Lastly, it must be said that our results are in reality very slight in severe cases with marked deformity of the thorax and bulging of ribs, in spite of the most energetic, varied, and expensive treatment. It is also worthy of mention that energetic efforts to produce mobility in a severe case of scoliosis which has not yet reached its height may under certain conditions be injurious and not beneficial. In certain cases fixation may be regarded as a natural cure, checking further deformity. In unfavourable conditions

increase of deformity may be produced by unintelligent attempts to increase mobility. In any case, a gymnast practising alone and not having access to suitable medico-mechanical apparatus is almost helpless, even if he possess the energy of de Ron.

It should be added to these remarks on scoliosis that a new method of treatment for mobility and correction has been recently developed. This method, developed by Klapp in his surgical clinic in Bonn, is based on the observation that four-footed animals bend the spine much more than human beings in walking and running. The method consists of performing certain movements in the four-footed position, which aim strongly at mobility. To what extent this method will come into use in the treatment of scoliosis cannot yet be estimated.

B. Deformities of the Extremities.

I. Anchylosis and Contracture of Joints.

In true anchylosis of joints, in which formation of bone or connective tissue and cartilage have caused a growing together of the articular surfaces of the joints, medical gymnastics and massage play no great part in the actual treatment of the joint. No treatment, whether manual or mechanical, can make a joint movable when there is no mobility in it; muscle gymnastics can accomplish just as little for the muscles when the joint upon which they work has completely lost its function. It is equally pointless to try by massage to keep in condition those muscles that are and must remain functionless. The only indication for medical gymnastics that is found in cases of anchylosis has to do, not with the anchylosed joint itself, but with the treatment of joints in close proximity to it. Through development of the utmost power of movement of the neighbouring joints by means of exercise the functions of a limb weakened by a defective joint can not infrequently be considerably improved, resulting in a kind of compensation to the anchylosis. It may be pointed out that the mobility of a limb necessary for the everyday functions of life certainly improves more by the patient's own continual efforts to perform the greatest possible movement and work with the anchylosed extremity than by short daily *séances* of medical gymnastics and massage. It may well be, however, that the patient gains his end more quickly by having definite practical *séances*. Again, attention may be drawn to the fact that joint anchyloses often arise after long and serious joint diseases (gonorrhœa, tuberculosis, purulent inflammation) or joint injuries, which for their primary treatment require

long fixation, by which the mobility of the neighbouring joints suffers severely. In such a case after-treatment by medical gymnastics and massage is of course absolutely necessary.

Under certain conditions, however, such anchylosis may be the object of operative treatment aiming at the restoration of mobility in the anchylosed joint. This operation, known as arthrectomy, is seldom undertaken, since the result achieved is often a fresh anchylosis. As a rule it is only undertaken when the former anchylosis occurs in such an inconvenient position that a new anchylosis in a more suitable position allows the patient a considerably increased functional activity, and also only in those cases where the anchylosis has not been the result of a joint affection of such a nature that it has a tendency to light up again after operative interference. The result of arthrectomy is of course *nil* if gymnastic treatment is not given as soōn as possible after operation for the mobilisation of the joint. On the other hand, it has often happened in recent years that mobility has been obtained in an anchylosed joint by such means, especially since the introduction of implantation of soft parts (fatty tissue, muscular tissue) between the operated free ends of bone. Where anchylosis, especially in certain joints, occasions great limitation of function, it is possible that such attempts to restore mobility will become more general.

Such after-treatment must not be looked upon as an unimportant part of orthopædic surgery, but as of primary importance, for which the operation only prepares the way, and must be undertaken in the same way as any other joint mobilisation. As in all other severe joint affections, and especially after operation, the treatment must be given with the greatest caution. It is not by heroic manipulation one gains the end in view. Violent reaction of the damaged tissues to the strength of the manipulation quickly destroys the mobility which is the immediate effect of very strong massage. Very small movements, constantly combined with massage and other means of softening (warmth, rest, cold compresses, etc.), produce a more beneficial result than the violent breaking down of adhesions formerly employed, or the now abandoned *redressement forcé*. If by such mobilisation of a joint one can obtain a mobility which is considerably under the normal mobility of the joint, it is nevertheless a great gain to the patient. The difference between the functional power of an extremity with one joint completely anchylosed and the same extremity with the slightest mobility in the same joint is very striking. It is scarcely necessary to call attention to the necessity in an individual case of increasing mobility round the resting position which corresponds to the patient's most comfortable anchylosed position.

By *joint contracture*, according to von Mikulicz (German Congress of Orthopædic Surgery, 1904), is meant " a partial or complete loss of either active or passive movement in a joint, excluding true anchylosis with firm union between the ends of the bones (by bone or connective tissue)." All stiff joints therefore come into this class, even a very partial, perhaps trifling, decrease of the normal mobility of a joint, or a complete stiffness approaching the limits of anchylosis. In all these cases of joint stiffness treatment by massage and medical gymnastics plays a prominent part. The important subject of physical treatment has already been discussed ; I will therefore confine myself to the statement of a few special orthopædic points.

The first question which interests us in the medical gymnastic treatment of stiff joints is, of course, when should a stiff joint be mobilised ? And the answer will be that every stiff joint should be mobilised if no definite contra-indication is present. The first contra-indication is a joint affection of any kind in the acute stage. It has been fully proved by experience, and is evident on reflection, that the final result of a joint treatment as regards function is best if one avoids increasing in any way the inflammatory reaction in the joint. This reaction is undoubtedly increased by too early and too violent movement, which unfortunately is often undertaken. Every diseased joint must therefore be given rest and fixation so long as it is painful on the slightest movement. Only when mobilisation without an anæsthetic gives no pain worth mentioning can such treatment be applied. Another contra-indication is if anchylosis is the result of tubercular disease in a joint or its immediate neighbourhood. A joint whose limited mobility is due to a preceding tuberculosis has always been a *noli me tangere* for the medical gymnast ; and this as a general rule unquestionably holds good. It must, however, be remembered that cases of tubercular disease of the joints often occur, perhaps most commonly in the hip joint, which are so slight and of such short duration that more or less mobility still remains after recovery. In such cases an experienced and careful doctor can without danger employ movement in order to increase mobility. It is often impossible to state definitely how soon the gymnastic treatment can be given without danger. The option must be left without reservation to the doctor who has followed the case throughout its entire course. It cannot be too much impressed upon gymnasts that all treatment of joint disease, acute or chronic, must be directed entirely by the doctor.

If the joint contracture is of such a nature that the joint has become fixed in a faulty position, the gymnastic treatment first

aims at placing the joint in an advantageous position, *i.e.*, correction. If an elbow is fixed in a too flexed position, the gymnast seeks to place it more or less at a right angle, which is the position of the joint in which an arm with a stiff elbow can best perform its functions. In the knee joint the position of extension is necessary for walking. It should here be stated that joint contracture, even without true anchylosis of the ends of the bone, may reach such a stage that mobilisation and correction are impossible by means of mechano-therapeutic treatment alone. The contracture may even be so severe that one can scarcely distinguish it from a true joint anchylosis. Without an anæsthetic, which is too often used in cases of differential diagnosis, it is generally possible by careful examination to state to what extent the disease is joint anchylosis or contracture. If one tries to move the joint, the muscles concerned actively resist if only contracture is present, but not if there is true anchylosis. Further, in extreme degrees of joint contracture one can clearly feel by means of fine oscillating movements in the joint that there is a slight amount of joint movement, which cannot be detected if large or violent movement is attempted. If any movement can be found it can often be greatly increased by the help of mechano-therapy ; if, on the other hand, the joint is fixed in an extreme position, surgical treatment in the form of operation on tendons, muscles, or bone is often necessary as preparation for the equally necessary medical gymnastic treatment. The forced mobilisation which was often done under deep anæsthesia is now seldom applied, and is gradually going out of use. It was too often found that the most energetic gymnastic treatment in one form or another could not prevent the secondary shrinking of soft parts, due to the reaction of the tissues to this violence, so that the contracture remained as before. A good result can be achieved only when the patient possesses enough energy and self-control to undergo daily and long-continued treatment in spite of severe pain, which treatment must begin directly after the breaking down of adhesions, when the joint is still very tender. In such conditions one tries generally to attain one's end by gentle means, following the principle laid down for the proper treatment of joint contracture by the distinguished orthopædist Gocht, that the correction shall be very gradual, done without anæsthesia and at the same time without pain, and for a period of several weeks. The correction of a severe joint contracture must be performed during separation of the articular surfaces as well as during mobilisation. All such treatment must be preceded and reinforced by massage, heat, baths, etc. All this makes it necessary for the treatment of severe joint contracture to be undertaken at institutes

or homes equipped for the purpose. In all cases where there is a possibility of maintaining the mobility of a joint there is wide scope for medical gymnastics, since as a rule all stiff joints should be mobilised as far as possible, except the post-tubercular cases.

As to the technique of mechano-therapeutic mobilisation, it can undoubtedly in most cases be given manually, although it demands a great amount of energy and perseverance on the part of the gymnast. Since the treatment must be given with the greatest caution, the result is never very rapid; on the contrary, a long time is required. For the mobilisation of joints a system of medico-mechanical apparatus has recently been constructed and used. I would specially mention Krukenberg's pendulum apparatus, which are extremely useful in joint mobilisation. These apparatus, unlike the general medico-mechanical apparatus, are not very costly, and can therefore be used independently of the large ortho-pædic institutes. Universal apparatus have also been constructed by the help of which most joint contractures can be treated by the same machine, which is fixed and arranged according to whatever movement is given. These apparatus do not lose patience, and work, therefore, a great deal better than any personal agent. Especially in the stage when the joint mobility is minimal these machines give a better result than gymnastics. Finally, it is the case here as elsewhere that a combination of all methods gives the best hope of progress.

II. Paralytic Joint Deformities.

Although paralytic deformities consist of joint contractures and arise in consequence of various forms of paralysis, and therefore form part of the joint contractures already under discussion, yet they form a special group in regard to treatment by medical gymnastics and demand special consideration here. This is the more necessary since the treatment of these deformities has recently changed so much by the introduction of new methods, and medical gymnastics is therefore only one of the various means of treatment.

These deformities originate after various diseases which affect the central motor apparatus of the brain or spinal cord, generally after an acute poliomyelitis, when the remaining paralysis in severe cases has reasonably been regarded as hopeless, and our treatment powerless. It is not only on account of the loss of functional power which of necessity follows every paralysis, but also because of the severe deformities which accompany this disease, that it has such a bad reputation. By observing the

manner in which these deformities arise we shall be able to find a method for effective treatment by medical gymnastics and massage for the different stages of the disease.

The muscles around a normal joint are grouped in such a way that they partly hold the joint in a certain resting position, partly permit a certain number of varied movements from that resting position by which the joint carries out the different functions of the limb. If one or several of these muscles become paralysed, the equilibrium is upset and the normal resting position is thereby changed. Since a partial limb paralysis often remains as the result of an acute poliomyelitis or similar disease, a similar change must take place in one or more joints. Thus arises the paralytic joint deformity, which is a joint contracture due entirely to muscle change. The treatment in such cases must be of quite another kind from that already spoken of in cases of contracture caused by joint disease. As long as there is a lack of equilibrium between the muscles around the joint a paralytic deformity is inevitable. By forced correction in such cases one can only bring about a temporary improvement if nothing can be done to replace the equilibrium of the muscles, or by some other outside means at least to counteract the recurrence of the deformity.

Medical gymnastics and massage have long played an important part in the attempt to restore the muscular equilibrium. The aim of the treatment by medical gymnastics varies a great deal during the different stages of infantile paralysis.

In the first stage of acute poliomyelitis, when the paralysis is often more widely extended than in the last fixed stages, it has been observed that thorough and regular massage and corrective exercises help in the restoration of the power of movement of the paralysed muscles. In paralysis due to poliomyelitis the reason why the paralysis is so much more widely extended directly after the illness than later on is due to the fact that not all the motor cells and paths which have been affected by the toxins of the disease have been destroyed, but that a greater or lesser number of the damaged cells are capable of recovery. To what extent medical gymnastics and massage can help in this stage of repair in poliomyelitis is uncertain ; but probably treatment does not play such a great part as has been ascribed to it by gymnasts. By this we do not say that such treatment has no effect in this stage. At any rate, the treatment helps in a great degree to prevent secondary deformity, which must certainly be treated by remedial joint movements given daily. When the case of poliomyelitis has got past the stage of repair and the definite paralysis has become completely stationary, and the gymnast as well as the patient and

his friends can see no further improvement, the treatment is left off by degrees, and the medical gymnast probably meets the patient again at a later stage in his life.

When the first medical gymnastic and massage treatment is discontinued the patient is often forced by necessity to manage with his functional defect as best he can, and thus the paralytic deformity gradually develops with mathematical certainty, the degree or nature of the deformity depending upon which muscles and how many have been permanently paralysed by this terrible disease.

In more fortunate cases orthopædic apparatus may often prevent the occurrence of any deformity and secure for the patient fairly good functional power, depending naturally on the degree of the muscular defect. But in many cases no benefit can be gained by such external apparatus. Muscles which are not acting in harmony with one another seem to possess an almost incredible power of producing deformity. It has often been observed how in paralysis of Extensor Communis Digitorum and the Peronei the corresponding typical deformity, pes equino-varus paralyticus, arises, in spite of a carefully-constructed surgical boot, and in spite of the fact that the patient was at first able to walk on the sole of the foot, so that the body weight at each step tended to prevent the development of the deformity.*

It is difficult from the economical point of view for even wealthy patients to give sufficient attention to orthopædic apparatus, for it is no easy matter to get the apparatus to fit and to keep it in good repair. After vain attempts to prevent the deformity many patients are at last forced to abandon the whole question of apparatus and the use of orthopædic supports, and the deformity, although originally it could possibly have been counteracted, must at last arise. One may say that only a very few of the wealthier class are fortunate enough to prevent the deformity by the use of apparatus. It arises gradually, and by its increasing functional effect often results in marked crippling. The patient then frequently seeks new help and advice, either from the physician or direct from the medical gymnast, who now meets a poliomyelitis in a quite different stage of the disease. Not even the most sanguine gymnast can give any hope of restoring the functions of muscles which have been paralysed for years. On the other hand, he may try by the help of manual correction and massage to soften the tissues and improve the circulation and thereby give the deformed limb a more normal appearance. This can be done

* We see here what great importance muscles in their healthy condition have in the development and maintenance of normal form and function.

successfully, without doubt, by hard work, and many gymnasts (de Ron, for example) have achieved successful results by very energetic treatment of these deformities ; but the deformity must of necessity recur when the treatment is stopped. The disease has therefore come to be considered hopeless. Recently orthopædists have attempted in their treatment to attaek the causation of the disease with undoubted advance in this hitherto thankless branch of orthopædics.

The deformity depends upon lost equilibrium between muscles and groups of muscles around a joint. This in turn depends upon the destruction of certain motor cells and paths by an aeute inflammation. This destruction is absolutely irreparable, and no treatment is of any use in restoring these centres, with their corresponding paths, to their respective functions. One must be content to treat this loss of muscular equilibrium by more direct means. With the aim of correcting the lost equilibrium between the muscles acting on a joint orthopædists have in recent years, and on the whole very successfully, tried to cope with paralytic deformities by operation.

The aim of restoring the lost equilibrium between muscles coincides with the aim of weakening muscles which are too strong, strengthening muscles which are too weak, and compensating for muscles which are quite paralysed. Muscles which are too strong can easily be made weaker by means of the old surgical methods, as, for example, by partial or total excision or lengthening of tendons ; and these operations greatly facilitate, and may in some cases be absolutely necessary to make possible, the correction of a faulty position. It is much more difficult to strengthen weakened muscles. Exercises play a predominating part in such cases ; but it is very seldom possible to strengthen a paralysed muscle to the extent necessary to enable it to oppose its healthy antagonists.

To compensate a completely paralysed muscle is of eourse much more difficult. The only method formerly employed to attain this end was the use of complicated supports with elastic bands and springs. This method involved to a great extent all the ineonveniences of the fixation treatment already referred to, and was, in the long run, unsatisfactory, although in certain cases it might considerably relieve the patient. Orthopædic surgeons have lately resorted to quite new methods for strengthening weak or compensating paralysed muscles, namely, by operative methods, such as shortening of tendons, transplantation of tendons, partial or total transplantation of muscles, thus distributing the remaining functional muscles so that the balance of power is restored with regard to the chief function of the joint. By these methods we

have greatly advanced in the treatment of infantile paralysis. The complete restitution of a joint, even in slight cases, cannot be fully achieved, for the muscle power must always remain less than in the corresponding healthy joint, yet mobility can be gained in all necessary directions and correction is maintained and relapse avoided. The result depends on the extent of the paralysis. The cure is, however, not terminated by the operation; much work in the form of "after-treatment" by gymnastics and massage is required in order that the result be successful. The medical gymnast-masseur stands now in quite a new position with regard to the poliomyelitis patient; and the aims before him can be best illustrated by a concrete example. We take a case of pes valgus paralyticus due to total paralysis of Tibialis Anticus. This deformity, which causes great trouble and functional inconvenience to the patient, who is constantly found walking with the internal malleolus on the ground, the foot completely rotated outwards, is dealt with by orthopædic means in the following manner:— Extensor Hallucis, being very considerably developed, is cut through at the tendon and its central end sewn on to Tibialis Anticus, and the peripheral end of Extensor Hallucis is sewn on to Extensor Communis Digitorum; thereby contractile muscle substance is carried to the completely paralysed Tibialis Anticus. It is obvious that the muscles do not immediately on healing begin to function in the way aimed at. Only by the help of a long period of correct exercises can this theoretically rational treatment lead to a practical result, and the medical gymnastic treatment is of a double nature. Partly, in extensive paralysis, weak and unimportant muscles or parts of muscles, which can be used to replace the lost muscle or function, may be strengthened by resistance movements in the ordinary way, *i.e.*, by ordinary muscle gymnastics. The more interesting aim is that these partially or totally transplanted muscles must be trained to perform entirely new functions. In this supposed case the conditions immediately after operation are as follows:—When the patient wishes to extend the great toe, and for this purpose contracts Ext. Hallucis, whose tendon is cut, no effect is produced in the great toe, but an inversion of the foot takes place because the muscle acts at the insertion of Tibialis Anticus. Therefore at first the patient is not able to invert the foot unless he thinks of extending the great toe. By practice, however, this necessity soon disappears, and it is not long before the patient can produce intentional inversion of the foot. In this way then the entire motor nerve path from the extensor centre of the great toe to Ext. Hallucis has been trained to a new function, namely, an inversion centre has been formed, and the motor nerve

from it has been utilised by a muscle of inversion ; in other words, the patient has acquired a new Tibialis Anticus. On the other hand, the patient has lost the power to extend the great toe by itself, and can only extend it at the same time as he does the remaining toes, a very slight loss in comparison to a great gain. When it concerns more complicated and more extended paralysis the matter is not so easy. In treatment of this kind one encounters many interesting problems in muscle physiology, which, although we have no real concern with them here, it seems suitable to touch upon in a few words.

While it is obvious, and in any case not surprising, that Ext. Hallucis can be trained to perform not only the synergistic but also in most cases the simultaneous function of Tibialis Anticus, it seems less probable that it should be possible to train a transplanted muscle to perform an antagonistic function. Still more wonderful is it to consider whether a divided muscle is able to perform different functions with its different parts. All the conditions connected with these questions have not yet been fully worked out, but during the research of recent years in connection with this method of treatment of paralytic deformities we have much extended our knowledge on these questions of muscle physiology.

We now consider it proved that a muscle which has been transplanted altogether can be trained to perform even an entirely antagonistic function ; on the other hand, we think it uncertain, or even improbable, that a divided muscle is able by practice to separate into two or more functional entities with widely different functions. By degrees, as a result of these experiences, we have somewhat changed the method of operation in the treatment of these deformities. Whereas formerly, according to Vulpius, even with extensive paralysis with very little area of unparalysed muscle, it was attempted by lengthy separation and partial transplantation of the muscles to make good all the lost functions of the joints, more recently we have followed Lange in attempting in severe cases only to obtain the most important functions of the joints by transplantation of the whole muscle, in doing which we must naturally choose the least important muscles, or one of two pieces of muscles with similar function (*e.g.*, peronei), as compensation for some important lost function. As a result of these methods we have undoubtedly made a great step forward in the treatment of these unfortunate paralyses ; and we have seen how the position of the gymnast-masseur in the treatment of these diseases has by this means become considerably more pleasant. Instead of wasting an unheard-of amount of work without corresponding result, he now

co-operates as a particularly important and absolutely indispensable factor in treatment which, if correctly planned and energetically carried out, always results in a real gain to the patient. Above all it must be emphasised that it is an essential part of this treatment that the masseur completely understands his task; that the whole of the plan and carrying out of the treatment is known to him in detail, so that he thoroughly understands what is expected of him. If this is not the case he soon nullifies by faulty gymnastics and harmful correction the good results of even the best-planned operation. In no part of practical medicine as in this is it so harmful for the doctor to hand over his patient to the medical gymnast without getting into personal communication with him; here, if anywhere, personal intercourse between the doctor and the gymnast, and the doctor's personal supervision of the treatment, are imperative necessities in order to obtain a good result.

III. Congenital Dislocation of the Hip.

In congenital dislocation of the hip also it may be said that better methods of treatment in recent years have brought with them a better outlook. Medical gymnastics and massage have also come into favour in the treatment of this disease in quite another way than formerly. Formerly medical gymnastics and massage were used quite frequently in treatment of congenital dislocation of the hip, but then this treatment proved itself as little effective as the treatment by leather apparatus and other pelvic girdles also frequently used, so that it eventually fell into disuse, and those children who were born into the world with this serious defect were too often left to their fate as entirely incurable.

A survey of the nature and special symptoms which make this defect so unsightly, the increased lordosis with the consequent backward-protruding pelvis, and, above all, the particularly ugly waddling gait, especially in double-sided cases, shows clearly that medical gymnastics and massage cannot have any curative influence upon this defect. The waddling gait, which with great injustice to the ducks is called duck-walk, is caused by the head of the femur having lost its support against the pelvis in the acetabulum, from the upper part of which, the so-called roof, the bone receives a firm support in a normal hip joint. If this support is absent the walk will be waddling, because the abductors of the hip, which are absolutely necessary for a steady gait, are not able to function. In order that a muscle shall be able to function, *i.e.*, to exercise its intended effect upon two levers, it is necessary that its attachments, the origin and insertion, shall not lie too near each other (for a

muscle can then only shorten itself a certain proportion of its length), also that the two levers are connected by such a joint that they are not able to move in any way against each other in that plane in which the angle of movement, in this case abduction, takes place. Neither of these conditions is fulfilled in congenital dislocation of the hip. The head of the femur lies in a somewhat movable position against the ilium above and behind the position for the joint cavity. The abductors, which every time the opposite leg is raised from the ground must fix the pelvis and so the whole trunk, are not able to do this on account of the too short distance between their origin and insertion, especially as this distance is further shortened by the upward movement of the head on the ilium when the whole weight of the body is thrown on the one leg. The opposite side of the pelvis therefore sinks, and, in order that the whole trunk, and with it the centre of gravity of the body, shall not move so far beyond the supporting area that the inevitable fall should result, the patient carries the upper part of the trunk back towards the supported side, thus causing the typical waddling gait. Even this ugly walk in the long run causes so much strain of the abductors, working in such disadvantageous conditions, that fatigue very soon arises, even to the point of inability to continue walking. The older and heavier the patient becomes, the more difficult are these mechanical conditions, and the defect progresses rapidly. As, moreover, the firm support of the femur against the ilium, so intermittent when walking, plays a very important part in the normal growth of bone, the patient becomes quite dwarfed both in growth and power as age progresses. In unilateral cases the waddling gait is less noticeable, but the marked and troublesome limp appears later. The increased lordosis and consequent prominence of the pelvis backward are the result of the fixed point of the pelvis on the femur being moved backward.

That massage and gymnastic treatment in these cases should be able to exercise any curative effect is obviously impossible. All that exclusive gymnastic therapy can do is to work up the abductors to the greatest possible efficiency ; in this way, at least for a short time, the waddling gait should become somewhat firmer and fatigue somewhat diminished. On account of the existing unfavourable mechanical conditions, however, this improvement can be only of short duration. And it is clear that the only rational treatment for this disease is, as with every other luxation, to replace the joint. This is generally with children much easier than reduction of a traumatic luxation of the hip, but the method has not yet given any result, because it has not been possible to maintain the restored position, so that relapse occurs as soon as the

patient again begins to use his leg. This is accounted for by the poor development of the acetabulum, especially its roof, in these cases. It is only during the last few years that we have been able to maintain the reduction by means of improved methods of plaster. Sometimes, though not often, an open operation is used in order to obtain and maintain the reduced position. By means of these methods and their universal use the treatment of congenital dislocation of the hip has made very great headway. And one may say, with regard to the result, that the majority of single and a large number of double cases, presupposing the treatment to have begun *early*, which is an indispensable condition, have been definitely reduced by skilful treatment. Experience, however, shows that function, even after an anatomical reduction, is very poor, and when the patient after treatment begins to use the legs and walk it is practically unaltered. The patient waddles nearly as much as before. This is because the patient only learns by practice to correct his walk and other movements in accordance with the entirely altered mechanical conditions. With practice his walk becomes more certain and natural. The patient obtains the best possible function very considerably quicker if this practice is directed scientifically, and massage and gymnastic treatment are used as early as possible. The medical gymnast is therefore an important factor in the treatment. It is, however, extremely important that this should be given correctly, and that the gymnast is clear as to what he is expected to do. We have seen an example of a gymnast who was given such a case of reduced dislocation of the hip for after-treatment, and who indefatigably began to " work up " the joint, stiff after a long fixation in a plaster bandage. Nothing, however, is worse, and by such treatment a good result of reduction may be spoilt and even entirely done away with. As it is so extremely difficult to maintain the position of the head of the femur in the badly-developed joint cavity, it is quite clear that extensive passive movements may easily destroy the slight connection between the two bones. This especially applies to adduction and flexion, which are therefore *absolutely forbidden*. On the other hand, active exercise of the extensors, and especially of the abductors, is indicated, and for this purpose suitable exercises form the chief part of the treatment. The practice of abduction is performed first with the patient in side-lying position with abduction of the leg, in the beginning without, later with, resistance; the practice of extension in prone-lying position. Abduction practice in standing position is also important, especially in the form of practice in walking and standing. The patient must practise standing without dropping the opposite side of the pelvis, and this

by degrees will become possible with the improved mechanical conditions under which the abductors now work. Further, the patient must practise walking without waddling, which is the same exercise. In this way a good walk is soon produced which sometimes may become quite normal; in other cases some waddling remains, but there is much more firmness than before reduction. That the functions cannot always be quite worked up to normal depends on the fact that the head and neck of the femur are often considerably deformed in congenital dislocation of the hip, and sometimes present a high degree of coxa vara, which also produces a certain amount of waddling gait, since in this deformity also the origin and insertion of the abductors approach one another beyond the normal distance, so that their efficiency is diminished.

Also in the treatment of these cases the medical gymnastic treatment plays a greater and more effective part than was formerly thought possible if carried out with full insight into the indications present.

IV. Flat-Foot.

Since, not only among the general public and medical gymnasts, but also among doctors, misconceptions are frequent in regard to this common deformity, which has generally gone under the unsuitable name of "flat-foot," several points may here be mentioned in connection with the treatment of this complaint. This is the more necessary as this complaint, which embitters the existence of so many people, is a typical example of the *weight deformities*. This large group of deformities has much of interest to the medical gymnast, so that I may also give some general points concerning their nature and the treatment they require.

By weight deformities we mean in practical orthopædics deformities which arise as a result of faulty weighting of one part of the skeleton. Since the position of part of the skeleton, normal or pathological, under all conditions is dependent upon all the forces which work upon it, in regard to mechanics every skeletal deformity is really a weight deformity, as in mechanics one means, when talking of the weighting of a lever, the combination of all those forces which work upon the same. The term "weight deformities" in orthopædics has not, however, such an extensive meaning, but by it we understand only that the normal form has become disturbed by pathological effects of the forces acting on a part, *i.e.*, in the first place, gravity. As a rule one is not concerned with the structure and use of living forces, primarily muscles. In its most limited meaning, as the term in question is most often used, by a weight deformity we simply mean a skeletal deformity which has

arisen by the effect of gravity, so that the part is not able to bear the weight put upon it, but gives way under it in one way or another. Weight deformities in this sense only arise, therefore, in the lower extremities, pelvis, and spine. In this way arise various forms of habitual scoliosis, genu valgum, coxa vara, and the so-called flat-foot, due to overburdening the respective part of the skeleton. Such disproportion between the weight and the power to carry the same may arise either by the weight which is to be carried becoming too great, or the power to carry the normal weight being lessened. The first takes place, *e.g.*, when, which not seldom happens, persons of middle age become corpulent and develop flat-foot. A weight may, however, become too great in proportion to the supporting power of the part of the skeleton, not only by being too great in itself, but by a weight, in itself not too great, being carried too long without rest, or in an uncomfortable position so that it weighs down the part of the skeleton. This happens when flat-foot arises in connection with certain occupations, *e.g.*, bakers' apprentices, waiters, nurses who are obliged to stand or walk a great deal, or among smith apprentices, who, if the hammer is too heavy in proportion to their youthful strength, stand astride with feet turned outward, which position, as we shall soon see, is especially apt to cause pathological flat-foot. As, however, in spite of such occupations, a great number of individuals escape this trouble, it must be stated that the second factor, the diminished power to fulfil the required task, is the most important cause of the disability. This inability on the part of the skeleton to fulfil the tasks given it may be the result of general weakness, so common in adolescence, when such weight deformities are prone to arise, or of other conditions of weakness in connection with anæmia, etc.; or it may also be due to special diseases of bone, such as rickets, osteomalacia, etc. And in those cases where no such obvious disease seems to exist one has sometimes used the term "juvenile osteomalacia," which expression, however, up to the present has not received any pathological or anatomical justification.

Since the mechanical conditions in weight deformities in general are such that the strain upon the part in question increases with the deformity, every weight deformity ought to increase gradually, and reach eventually an extreme degree. This, however, is not the case, such severe cases being actually very rare. This must be accounted for by the fact that nature possesses resources which do not exactly counteract the deformity but at least prevent its further development. This power of the organism to react against deformity is made up partly of vital reactions in the bone itself, by which the bone is able, especially after recovery from rachitic

or similar bone condition or general weakness, to respond to the altered weighting by the formation of new bone substance arranged in a way suitable to the changed weighting. Further, muscles play a very important part in counteracting weight deformities, and one often sees how those muscles which are able to counteract a deformity which has arisen are hypertrophied to a high degree. This everyday circumstance contradicts the theory which gives insufficiency of muscle as an important primary factor in the development of weight deformities. Only after the muscle can no longer be further hypertrophied does the deformity get the upper hand. As, however, musculature in general plays such a dominating part in the maintenance of normal skeletal form, and even specially counteracts the development of deformities and their progress, it is obvious what a large part medical gymnastics takes in the treatment of weight deformities. But that this must not be exaggerated, as is often done, will be shown more clearly in the following account of the treatment of so-called flat-foot.

By flat-foot in practical medicine is meant a foot which is flat, *i.e.*, with sunken arch. Nothing, however, in actual fact is more incorrect. Many patients seek the assistance of a doctor or medical gymnast for the unbearable so-called flat-foot pain and show on inspection a highly-arched foot. The name flat-foot is thus somewhat unsuitable, and has arisen on account of the relation between the bony skeleton of the foot and the bones of the lower leg being overlooked, and diagnosis of this common trouble arising as a result of overweighting the foot being made on the isolated skeleton of the foot itself. If, however, one takes the ankle joint into consideration in the diagram, one gets an entirely different and much more correct idea of the nature of the trouble. This consists by no means exclusively, or even chiefly, of a sinking of the longitudinal and transverse arches of the foot, but much more of an eversion of the foot in the ankle joint, a valgus position of the same. The line of direction of the lower leg and heel seen from behind even in normal conditions forms an obtuse angle outwards. The strain on weighting must therefore be uneven, the ligaments and capsules on the inside being more strained than those on the outside, where there is rather a compression of the parts of the joint against one another. On over-weighting this stretching of the inner side increases, and causes the severe pains, which are always localised to the inner and under side of the foot. One can demonstrate mechanically that this strain of the ligaments on the inside becomes greater the further the ankle joint is from the supporting area; so that these flat-foot pains should arise more

easily in high-arched than in low-arched feet. Similarly the strain becomes greater with the feet rotated out. This is also actually the case. In studying patients with symptoms of flat-foot carefully, many of these, and above all those who have most pain, are found to have high arches and not flat feet. Under such conditions, to say the least, it is unsuitable to call these pains flat-foot pains, as they are of exactly the same nature whether they attack feet with low or high arches. The name is all the more unsuitable as its use leads to the patient not being able to have his symptoms correctly diagnosed by the doctor and gymnast; it is difficult to make the diagnosis "flat-foot" in a foot which is not at all flat but rather highly arched. The correct treatment cannot be applied, and the trouble persists. Only in the last stages of such a weight deformity, when the patient has not been treated or all treatment used has failed, does the arch really become sunken and the name flat-foot become justified. An everted foot (pes valgus) thus becomes an everted flat-foot (pes valgo-planus). The earlier stages of pathological flat-foot pains should not have this name, which ought to be done away with. These pains, which often in earlier stages cause much inconvenience to the patient, and which, moreover, are very common, ought instead to be called by their right name, weight pains or static pains, or, as Schanz and at about the same time the author of this chapter recently suggested, "*insufficientia pedis.*"

Pure flat-foot without eversion in the ankle joint (pes planus) arises as an anatomical variation, as a family or race peculiarity, but seldom gives rise to weight pains. And by investigations in armies we have found of late years that recruits with flatter feet, *i.e.*, lower arches, can on the whole march longer and more seldom get weight pains than those who have high arches.

Without going more into detail here concerning the symptoms of these pains and their diagnosis, we may give only those which are common to all, however various they may be. They always arise when the foot is weighted and disappear during rest. The aching and tenderness felt on palpation are always met with on the medial and plantar aspects of the foot. And the frequency of these cases is such that, without exaggeration, one may say 80 per cent. of all patients who seek advice on account of foot trouble suffer from weight pains. Finally, it may be said that these cases ought by no means to be scorned or neglected by the doctor, as often happens; the trouble must, on the contrary, be looked upon as serious, and in those cases in which suitable treatment does not have the desired effect may compel the patient to change his occupation, which is no trifling matter.

As regards medical gymnastics and massage in the treatment of these patients, it has often been said that this form of treatment forms the sovereign remedy for such cases of flat-foot. This, however, is only true in a modified sense. They both, without doubt, play a great part, but a little thought will at once show to any one who understands the nature of the disease that such treatment must nevertheless in a large number of cases be quite insufficient.

The mechano-therapeutic treatment of this disease consists partly of gymnastic exercise of certain muscles, partly of massage applied locally to the tender parts of the foot. This last is especially beneficial when, as often happens, by continual strain of the capsular ligaments on the internal and plantar side they become irritated and cause œdema, infiltrations, and effusion.

From the standpoint of treatment of the cause massage is less important than gymnastics. The most prominent deformity lies in an exaggerated valgus position of the foot, *i.e.*, a position of eversion, and this faulty and unfavourable condition of the bones of the foot causes weakness, and so the trouble arises. We must try by gymnastics to exercise the muscles of inversion to the greatest possible extent. And it is evident that the increased power of the muscles of inversion will be able, at least for a time, to counteract the deformity and to prevent the increase of the symptoms. Yet this is often done without the help of gymnastics; for in many cases it may be found that Tibialis Anticus, the chief muscle of inversion, is considerably hypertrophied. A muscle cannot be exercised beyond a certain point; sooner or later it reaches the limit of its functional power. When the unfavourable mechanical conditions increase and put more and more strain on the muscles of inversion, at last there comes a time when the muscles are forced to give way and the deformity increases. Contrasting with the strength of the muscles of inversion in the early stages, in the later stages when the deformity has reached the severe form of pes valgo-planus these muscles are seen to be somewhat atrophied. The deformity has thus reached that stage when other mechanical conditions, especially the fact that the inner border of the foot touches the ground, prevent further development of the deformity and the muscles are of no further service.

In the vast majority of cases of weight deformity, which are only temporarily relieved by massage and gymnastic treatment, and return as soon as treatment is left off, the orthopædist must, as in other similar conditions, avail himself of external mechanical means to increase the power of the weakened muscles by inversion.

It is important to keep the foot in the normal position, or slightly inverted, while it is in use, *i.e.*, while the weight of the body is resting on it. Without further discussing the means which are resorted to in order to correct the position of the foot, it may here be mentioned that these all simply aim at placing the foot on an inclined plane, with its inner border raised. The foot is thus brought when weighted into an inverted position. We often find, moreover, that the patient has resorted to this method by instinct; also that in walking, the patient with one-sided flat-foot, or with one foot worse than the other, tries to avail himself of any slope of the ground, *e.g.*, the edge of the pavement which suits him best, in order that the painful foot may have its inner border higher than the outer. Frequently we find by examining the patient's shoes that the outer side of the heel is well worn away, showing that the patient in walking has tried to prevent, by means of inversion, the ligaments and capsule on the inner side from being stretched and thereby causing pain. In orthopædics this inversion is produced by means of specially-built shoes with slanting heels (the inner side of course higher), or by means of a movable flat-foot arch of various materials and shapes. It is also clear that the physician must direct his attention to the various conditions which may have caused this deformity, such as rickets, anæmia, etc. Treatment of the cause, which is the most effective, is to give up standing and walking as much as possible, and in most cases is equivalent to changing the occupation, which the patient will not do unless it is absolutely necessary.

There is not much that can be said here of the gymnastic technique in this case. The only exercise that can be beneficial is inversion; and this can be done mechanically by apparatus with resistance or manually with resistance. There are two excellent machines suitable for this purpose constructed by Krukenberg and Zander (notice especially Zander's excellent machine B : 13). The patient is also able to do a very effective inversion alone. Heel-raising, toe marching, and running with parallel or inward rotated feet, are all excellent exercises for the muscles of inversion, especially Tibialis Posticus and the muscles of the calf, which are of great importance in inversion when the foot is plantar flexed. The medical gymnast must of necessity himself find out exercises in this as in other cases which attain the desired end, and therefore he must be thoroughly acquainted with his work. Should the gymnast fail to do this, the result of his treatment will be of little value. We frequently find flat-foot treated exclusively by energetic local massage on the tender spots, the least important and least effective part of the treatment.

V. Congenital Club-Foot.

Since congenital club-foot is of a very different nature to that of paralytic origin, the treatment of the latter being carried out on the same lines as that of any other paralytic deformity, a few remarks may be made here on the gymnastic treatment of this not uncommon defect. There are many different theories relating to the origin of this deformity, but the most likely is that the cause of club-foot is found in a bad position of the feet of the fœtus in its early stages; and thus it is that many cases can be said to belong to the intra-uterine weight deformities. Should the development of a fœtus take place while either one or both feet are in a faulty position it is quite evident that the skeleton as well as the soft parts belonging to it will take that form which is most convenient and will therefore develop into bad shape and proportions. The longer this faulty position has lasted the more the tissues accommodate themselves to it, and the greater is the resistance offered by those faulty parts to any power that is present to place the limb in its normal position.

The theory of the treatment of congenital club-foot seems quite easy to understand. It is of great importance that correction should be used in the earliest stages, also that suitable appliances should be used to fix the foot, in order that further growth may take place with the foot in a normal position, whereby the skeleton and soft tissues are compelled to return to their normal form and proportions.

It has already been shown how impossible it is for gymnastics and massage to be of sufficient force to correct a moderate form of this deformity when the patient is older; yet this theory does not apply to the case of infants. The tissues of an infant have not become so fixed that they offer a very strong resistance to this form of correction. Ossification of the cartilage of small bones like those of the foot has scarcely begun.

One often finds that even a high degree of congenital talipes equino-varus can, by energetic manual treatment alone, be corrected by degrees, though possibly not at the first attempt. It is important that manual correction should be attempted immediately after birth, and the cure of every case of congenital club-foot should be possible by this means, since fixation in the corrected position can be easily achieved by means of bandages, the resistance of the tissues being so slight.

Experience shows that one generally sees congenital club-foot after the child has begun to walk, either in its original stage or worse. The reason for this is that, however simple the treatment

is for infants, those in charge of the child seldom carry it out correctly or for a sufficiently long period. In the end it is generally necessary for a medical gymnast to carry out the treatment. Social and practical inconveniences are often causes which prevent a lengthy treatment, the most important thing being the great expense of massage and gymnastics, so that it can easily be understood why many congenital cases are left till too late, for the older the child the greater are the difficulties in treatment. These difficulties become so great that even severe surgical operations fail to give a satisfactory result.

Under these conditions it is necessary for a child born with clubfoot to be at once ordered energetic medical gymnastic treatment. I will here give a few practical hints as regards this particularly easy treatment.

The aim is, naturally, to reduce the foot to its normal shape. For this it is necessary to give manual correction daily, preferably several times a day, and with great energy and patience this can often be accomplished. One must not make the mistake of thinking that the correction is easier than it really is. It is quite simple at first to correct the whole anterior part of the foot so that the whole anterior part of the sole looks downward as in the normal walking position. The condition with regard to the heel is quite different. Part of this faulty position consists of the equinus position of the heel with contraction of the Achilles tendon, and sometimes even the equino-varus position of the heel. It is more difficult to correct the posterior part of the foot than the anterior, which is more supple than the heel, and is not so difficult to grasp as the undeveloped heel of the infant.

Now if the anterior part of the foot is fully corrected, but the heel left in equino-varus position, the deformity is bound to recur, as is proved by experience and by the study of anatomical and mechanical conditions. The bad position of the anterior part of the foot recurs, and no result is achieved. If, however, the medical gymnast treats the heel as primary from the first, it is more possible, in spite of the slight development of the os calcis, to correct the faulty position by means of stretching the shortened Achilles tendon. In order to do this successfully I strongly recommend the following method :—The child lies on his back with the sole of the foot (at least the anterior corrected part of it) against a hard surface, *e.g.*, the edge of a table. By flexion of the knee it is possible to imitate the natural support of the foot as when standing, and by using the leg as a handle one is able to correct it by natural means, the foot being fixed against the hard surface. This is a much easier method to bring about an effectual correction

than by trying to correct the foot directly by fixation of the leg. The exaggerated flexion of the knee, especially with fat children, may present difficulties, but this can be prevented by the gymnast placing a book or piece of wood against his own chest with the sole of the foot on it and pressing the whole of the sole against it. By this or similar treatment it is quite possible in nearly every case, if the conditions are favourable and the treatment given long enough, to correct this deformity. Generally it is necessary to over-correct. Between the treatments it is important that the corrected position be maintained ; with infants this is done by means of bandages and with older children (more than four months old) by the use of suitable irons. In this, again, the same difficulty is present, namely, that to maintain the correction of the anterior part of the foot is much easier than that of the posterior part. But with a little practice, even with the use of only soft bandages, one soon learns to adjust the bandages in such a manner that the greater part of the correction is maintained. Others beside the gymnast must learn to bandage in the same manner in order that the care of the child in regard to washing and baths in the usual way is not unnecessarily interfered with.

If this gymnastic treatment be continued until the child can walk a good result is to be expected. If the child places his foot on the floor in a correct manner when he begins to walk, standing and walking will be good corrective exercises for him. If, on the contrary, there is any remainder of an incorrect position, which always depends on insufficient correction of the heel, the tendo Achillis especially not being sufficiently stretched, the treatment must be continued and combined with the use of suitable mechanical support. It may, however, be so difficult to stretch sufficiently the contracted tendo Achillis that it is often necessary to employ partial or even total tenotomy with subsequent plaster bandages. For older children this is frequently absolutely essential, and then the treatment is not always entirely successful, and a more severe operation is often necessary. Yet the principle of the treatment remains the same, namely, to make the sole of the foot touch the ground in walking long enough to force the bones and soft tissues to take by degrees the shape necessary for normal function. In order to guard as far as possible against return of the deformity, whether in the case of an infant's club-foot corrected manually, or in the case of older children or adults corrected by stronger surgical orthopædic methods, it is necessary to use orthopædic apparatus, besides continuous treatment by massage and gymnastics, for a longer or shorter period, as circumstances permit. Orthopædic apparatus of various kinds suitable for this deformity

are to be found, from the very simplest and cheapest surgical boots to the most complicated and expensive, but also more effective, supports.

When the treatment of older children and adults demands the use of massage and gymnastics alternately with plaster bandages, one uses, besides forced correction, active muscle exercises, specially emphasising the evertors. The evertors are usually very weak, especially in one-sided cases, so much so that it has often been suggested that the cause may be poliomyelitis or similar disease occurring in fœtal life. With infants active muscle exercise cannot of course be used.

The treatment of congenital club-foot is of a very variable nature, according to the nature and stage of the illness. Lastly, I must remind my readers that the best result is to be gained, as in many other instances of orthopædics, by energetic, methodical, and conscientious co-operation between the medical or surgical specialist and the gymnast.

The above brief description of the treatment of a few different orthopædic cases ought to be sufficient to give the reader interested in these laborious, tedious, but often satisfactory orthopædic cases some idea of how to judge to what extent massage and gymnastics can be of use, and also in what way they should be used. It is important on the one hand to take care not to over-estimate one method of treatment so that another necessary treatment is set aside, but, on the other hand, to see clearly of what inestimable help rationally applied medical gymnastics and massage really are in the treatment of orthopædic cases; in certain cases this mechano-therapeutic treatment, if used with sufficient understanding of the underlying aim, really works wonders. If these remarks in the smallest degree prevent the reader becoming dogmatic or one-sided and fanatic in his contest for "the system," for one or another "method of treatment," they have fulfilled their aim.

CHAPTER XII.

BONES AND JOINTS—SCOLIOSIS AND FLAT-FOOT.

We know that physical exercise is necessary to develop and maintain the normal size, firmness, and shape of the bones, and that in this respect gymnastics has a prophylactic and hygienic value. We have also seen *the therapeutic importance of gymnastics in connection with changes in the bones and ligaments.* At first sight movable pressure on the soft parts does not seem likely to exert any influence on affections of bone, *but, where anatomical conditions favour its use, effleurage has a definite and valuable effect on the healing of bone after injury by improving the local circulation and nutrition.*

Gerst has shown that after violent contusions of the leg resulting in necrosis and absorption of bone substance in the tibia, healing and repair take place with astonishing rapidity when effleurage is used over the limb.

Effleurage of the front of the neck has also been shown by Gerst to have a similar influence in severe blows on the head with concussion of the brain, intracranial hæmorrhage, and probably in fracture of the base of the skull.

I pointed out (in the eighties) that in the absence of callus formation, and when pseudarthrosis has formed after fracture, effleurage has the power of producing bony union in a comparatively short time even when all the usual methods have failed owing to bad general nutrition. The case then quoted was that of a dressmaker, aged forty-two, who had been delicate all her life, and who broke both bones of the right forearm in the middle. The arm was first kept in plaster of Paris for six weeks, and was then operated upon by Professor Berg, who sutured the ends of the bones, but ten weeks after the operation no trace of callus appeared. By means of effleurage, at first twice, later once, a day, taking care not to allow the least rubbing of the bony ends against each other—this rubbing had been tried most energetically with a view to producing callus before effleurage was begun—callus formation began within a short time, so that bony union was complete after six weeks' effleurage, during which time all other treatment was withheld. I consider this case a clear and convincing experiment. I have since been able many

times to observe the great influence of effleurage on callus formation, as well as on healing processes in general, in those parts which are most suitable anatomically for this manipulation, *i.e.*, in the extremities.

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Though massage was used in the olden days in the treatment of joint affections, it was in the middle of the nineteenth century, through the influence of the French surgeon Bonnet, that this treatment became general. Gymnastics, especially in the form of passive movements, has always formed part of the treatment of such cases.

At the present day a treatise on joint affections is difficult, chiefly owing to our ignorance of their ætiology, and to a great extent to the faulty use of the rather vague term rheumatism. By adopting the classification of Hildebrand in his manual (1905), with a few alterations mainly in accordance with Payr, I hope to give a fairly good survey of the whole subject.

Traumatic* Joint Affections.

A. Contusions.
B. Sprains.
C. Dislocations.
D. Fractures.
E. Penetrating ulcers.

Non-Traumatic Joint Affections.

A. Acute Non-Traumatic Affections.

1. Causes unknown.
2. Metastatic and bacterial arthritis.
3. Secondary arthritis (lymphangitis, erysipelas, phlegmon).

All those acute affections which are not caused by trauma we classify further, according to the nature of the exudation, into serous, serofibrinous, fibrinous, seropurulent, and purulent joint affections. The purulent may be more or less freely purulent, and the prognosis varies accordingly. The cases of so-called catarrhal purulence, in which staphylococci are often found, are of least significance. Streptococci give rise to more serious inflammation, sometimes with putrefying pus mixed with gas, and in such cases there is much greater danger of infection. Gonococci give very varying inflammatory products (further details below).

* It would be perhaps more correct to say "directly traumatic." A trauma may lead to hydrarthrosis, to circumscribed capsulitis, to arthritis deformans, or may even cause the development of a tubercular focus.

B. Chronic Non-Traumatic Joint Affections.

The most general, and from our point of view the most important, are the first three in the following list :—

1. Chronic serous synovitis, hydrops articuli, hydrarthron, "Water in the joint."
2. Chronic progressive polyarthritis.
3. Chronic rheumatism in the joints following rheumatic fever. Other secondary affections of the joints following other infectious diseases.
4. Arthritis deformans.
5. Tuberculosis of joints.
6. Syphilis of joints.
7. Neuralgia of joints.
8. Joint affections in diseases of the central nervous system (tabes).
9. Gout.

All these are concerned to a certain extent with massage and gymnastics. Hæmorrhage, tumours, and ganglion affecting joints may here be omitted. I shall refer later on, if necessary, to such pathological conditions of joints as anchylosis, loose joints, and non-traumatic dislocations.

The *Traumatic Joint Affections* are extremely common, and form the majority of the cases at clinics where the patients are for the most part manual workers.

Before I speak further on the treatment of traumatic joint affections by massage and gymnastics, I must point out that this treatment is contra-indicated in recent fracture, and in such cases is only indicated when the first stages of healing and the formation of callus are assured. In all cases of trauma it is therefore important to diagnose *the absence* of a fracture before beginning treatment. This can be done by noting *the absence* of deformity, of abnormal mobility at the seat of fracture, of abnormal position, of altered measurements and of crepitus, usually accompanying fracture, and the examination of difficult cases has been much simplified by means of X-rays.

Contusions (= crushing blows) of joints may vary to almost any extent in their effects. In most cases they give nature such a short and trifling work of repair, and give the patient so little trouble, that they are not often treated. *In other cases contusions may cause infiltration in the capsule without effusion in the joint cavity, a so-called circumscribed capsulitis, a very important joint affection from the point of view of the masseur. Even if the infiltration in the capsule is quite slight, so that it hardly affects the shape of the joint, or can only just be detected by palpation, with many people who otherwise have never seemed to be at all "neurotic" it may cause such trouble that a patient cannot use the joint. Inactivity*

leads to atrophy and contraction of the limb, and the patient, if, for example, the knee is affected, may never be able to do without crutches.

In some extreme cases an acute serous synovitis results, which may become chronic.

A contusion may also cause the development of gout, arthritis deformans, or tuberculosis in a joint.

Contusion of a joint is therefore something which ought always to be taken seriously, and which the masseur, whose treatment in such cases is the most important of all, ought to see completely cured before he leaves off treatment.

Muscles, nerves, and bones may also be more or less injured by contusion of a joint (see Chapter XIII., dealing with Traumatic Myositis and Neuritis).

In the case of a simple contusion the treatment consists of a raised position, with or without an icebag, rest and massage. The compression bandage and the more or less firm bandages which were sometimes used formerly have been abandoned wherever massage is in general use, and are superfluous in dealing with simple contusions. A sling is generally used for the arm. Massage should begin immediately after the trauma, and at first, while the part is much inflamed, should consist exclusively of effleurage, given twice a day if possible. If the absorption of the infiltration is slow, harder and harder frictions may be given as time goes on.

After *Sprains or Wrenches, i.e.*, after violent, generally passive movements which, though beyond the normal limits, have stopped before causing a dislocation, we find the joint acutely inflamed and the ligaments strained and possibly torn (and extravasation of blood). In these cases massage has very much lessened the prolonged application of firm bandages, which were formerly used. It has also even improved the prognosis, which was already good, hastened complete recovery, and lessened the number of those cases in which a sprain, like other traumata, gives rise to lengthy and more serious troubles. *The value of effleurage as an anti-phlogistic and in aiding nutrition is well shown in those cases where effleurage is begun immediately after the trauma and continued until recovery is complete. Even when parts have been torn, Swedish doctors do not generally use tight bandages; in fact these bandages have fallen almost entirely into disuse in the case of the ankle joint. But when one of the lateral ligaments of the knee is torn or detached from the epicondyle of the femur or tibia the joint must be absolutely fixed for fourteen days, to help it to heal in the proper position and to prevent abnormal side movement and an abnormal position later on. Normal movement can be restored afterwards by means of massage and*

gymnastics. In the case of those sprains, with or without tearing of the parts, in which we avoid tight bandages we always order rest and employ massage without movements for the first few days after the trauma.

From time immemorial (Hippocrates) it has been the custom to stroke and rub a *dislocated* joint after its reduction. By *Dislocation* is meant that the articulating surfaces of a joint are partly or entirely removed from one another by excessive movement or by some other force. If large vessels are torn, which is a rare complication, massage, just as in the case of fracture, should be postponed. But this is not the case if the nerves have been stretched or bruised; nor do bruised or strained muscles contra-indicate massage, but on the contrary are cured by it.

Treatment by effleurage and frictions may thus be given in most cases immediately after reduction. It is usual to wait until the most violent symptoms are over before giving movements. I may, however, remark here that a Swedish doctor well versed in mechanotherapy seldom waits more than eight, never more than fourteen, days after simple dislocations, of which the commonest are those of the shoulder, before he begins careful passive movements, as soon as possible performing these through the whole normal range of movement.

After *unreduced* or *irreducible dislocations* massage and gymnastics are often of very great use in procuring no small degree of movement in the pseudo-joint, or rather new joint, formed between the dislocated head and the surrounding tissues.

Fracture in or near a joint is in most cases an indication for massage, in all cases for gymnastics, but only after union has taken place, which is produced by fixation and complete exclusion of all movement, but is striven after in many different ways. *At this point I wish to call the reader's attention to the importance of thoroughly understanding the difference between fixed apparatus on the one hand and massage and gymnastics on the other.* Splints or fixed apparatus certainly assure union in a normal position, but they have an unfavourable effect on circulation and nutrition, causing stasis with passive inflammation, and, what is worse, various kinds of atrophy, especially that tiresome kind known as atrophic shortening. Surgeons have, quite naturally, generally thought more of the importance of union in the right position than of the future power of movement, and have erred in using too heavy apparatus and in using it too long. But, on the other hand, masseurs and gymnasts, with or without medical training, have often put themselves in the wrong and caused tiresome complications through their keenness to try their treatment, and through

their one-sided views as to its proper place and the disadvantages of fixed apparatus. At the present day, besides doing away with all methods which do not result in complete union and a good position, there has been a tendency as a whole only to make use of fixed apparatus so long as it is essential, to make the apparatus easier of application by exchanging heavy plaster of Paris for splints, or by converting the plaster of Paris case into a capsule by cutting it along both sides. This capsule, like other lighter apparatus, can be removed during massage and then replaced. This modern treatment, which in the case of intra-articular fractures often includes suture of the fragments, is known to hasten the union of the fractured parts. Nowadays intra-articular fractures are seldom fixed and left undisturbed for more than eight, never for more than fourteen, days. As soon as this time has elapsed massage is begun, and soon after gymnastics, to counteract and efface the harmful effects of the apparatus. Just as bandages prevent, so effleurage hastens the flow of blood and lymph in the part to which it is applied, and also improves the already lowered local nutrition. Both effleurage and frictions help the absorption of the products of stasis, and of the more or less plastic infiltrations. Passive and active movements entirely prevent the harmful results of immobilisation, already frequently mentioned, on joints and muscles.

After the healing of *penetrating wounds of a joint* the aim of the masseur varies between breaking up by means of effleurage and frictions the slight infiltrations left in the capsule and surrounding tissues by a non-infective trauma, and restoring as far as possible the use of a joint after purulent synovitis, which has not caused anchylosis and utter uselessness of the joint, but has at least seriously injured it. In the same way that modern antiseptic treatment has, to a great extent, increased the probability of saving joints from complete destruction when penetrating wounds or some other cause have made them purulent, a rational use of mechano-therapy has increased the chances of regaining the power of movement in a joint even in severe cases. There is an infinite difference in the prognosis given now and that which would have been given about 1850 with regard to a patient with a penetrating wound of the knee joint.

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A great many of the *Non-traumatic Joint Affections* are caused by acute exanthematous fevers and other infectious diseases. With *metastatic or bacterial affections* of the joint there is almost always at some stage exudation into the joint cavity. The changes which take place and the prognosis depend mainly on the nature

of this exudation. In most cases of arthritis due to whooping-cough, dysentery, ague, influenza, and rheumatic fever it is mainly serous. In cases of measles, pneumonia, scarlet fever, diphtheria, typhus, typhoid, mumps, and erysipelas the exudations vary considerably, and are sometimes mainly serous, sometimes mainly purulent, but usually something between the two extremes, *i.e.*, serofibrinous or seropurulent. Those forms of arthritis which have their origin in the urinary tract, due to gonorrhœa or the use of dirty instruments, always vary very much. They are sometimes monarticular, sometimes polyarticular, and may be purely serous, serofibrinous, purulent, or even phlegmonous, should the process immediately become purulent in the capsule and pericapsular tissues. In cases of smallpox, glanders, puerperal fever, septicæmia, and pyæmia, the exudations in the joints are often more freely purulent.

The nature of the primary disease thus gives us a clue, though not a very certain one, as to the character of the exudation, an important feature in the prognosis. In an advanced case of pyæmia, even when abscesses occur in the neighbourhood of the inflamed joint, *it may happen* that the exudation is purely serous and that it is quickly and entirely absorbed. On the other hand, we all know what serious effects acute rheumatism may have on the joints owing to infiltrations, hyperplasia, contractions, and morbid changes in the cartilage and bone.

As far as the purely serous exudations of metastatic or bacterial inflammation are concerned, they cause no fever, little swelling, but little visible redness, or pain, slight infiltration in the capsule, and do not generally produce a position of contracture. In such cases there is every chance of complete absorption and recovery. A metastatic serous affection of a joint is not treated so long as the primary disease causes the patient to have any fever. When the fever is over the exudation has often been absorbed, and the power of movement, which for the time is very limited, or even appears lost, is soon restored by massaging the slightly infiltrated capsule and by means of passive movements.

The freely purulent or phlegmonous forms of arthritis are the direct cause of fever and disturbances of the general health as well as of marked redness, infiltrations, and considerable swelling in and around the joint. Tenderness on pressure over the joint and pain on movement are very marked, and, by reflex action, the patient keeps the joint fixed in the position representing the maximum capacity of the cavity. *A permanent contracture is frequently developed, and a doctor always gives up hope of complete recovery in cases of free purulence.* He must be glad if by means of incision, drainage, and

antiseptic douching he can prevent the pus damaging the synovial membrane, capsule, ligaments and cartilage—in other words, if he can procure a joint which shows any signs of recovery without anchylosis and of a moderate functional power in the future. When the inflammatory processes are really over and the joint has healed, even in hopeful cases it is surrounded by hyperplasia, which quite disguises its shape, the capsule has lost its elasticity, shortenings of the muscles make the chances of curing the contracture small, and the joint becomes a life-long source of pain, especially susceptible to changes in the weather. Often many years elapse before, by daily use of the joint and by nature's own work of repair, power of movement is acquired, limited no doubt, but the greatest of which the joint is capable.

The symptoms and prognosis of serofibrinous and seropurulent inflammations of joints vary according to the nature of the exudation, which is sometimes more serous and sometimes mildly purulent.

Even though the prognosis of an arthritis depends largely on the nature of the exudation, there are also other points of very great importance, among them the patient's age, his general health, and —I lay special emphasis on this point—his energy and determination in carrying out the treatment.

Though it may be necessary during severe fevers with purulent metastases in the joints to postpone massage and passive movements, until the fever is over and the joint healed, both from the inflammation and surgical operations, I wish to point out that it is a grave mistake on the other hand not to begin this treatment as soon as it can be done. It must not be forgotten that the sooner frictions (which are always the most important manipulations in these cases) are begun, the less completely are the infiltrations and hyperplasia organised into connective tissue, and the sooner these are absorbed and the earlier movements begun the less conspicuous are the changes which result from lengthy immobilisation. Among doctors, without a doubt, the mistake of delaying too long in beginning massage and gymnastics after purulent inflammatory processes is commoner than that of beginning too soon.

The tubercular and syphilitic affections of joints deserve a special place among infectious diseases with regard to treatment, and massage and gymnastics are here of comparatively little importance.

Most medical practitioners agree that *Tubercular Affections of Joints* should not be treated by massage and gymnastics, and I too am of this opinion with regard to all those cases in which tuberculosis is actually going on in the joint. In one-fourth or one-third of the total number of cases this process begins in the synovial

membrane (Schüller), and one can easily imagine that especially in these cases massage might aid the spread of infection. In later stages of tubercular joints purulence often contra-indicates massage.

On the other hand, it is my opinion, grounded on my own experience and on that of others, that by means of massage and gymnastics one can often very considerably increase the power of movement in joints where there has been tuberculosis, but which have not been destroyed and in which a certain power of movement is still found.

The *Syphilitic Affections of Joints* vary endlessly in their pathological anatomical conditions. There is no reason to massage the serous, subacute, and generally multiple synovitis which sometimes appears in the secondary stage and entirely disappears with anti-syphilitic treatment. Syphilitic osteitis, periostitis, osteomyelitis, and the carious, often purulent, arthritis occurring in congenital syphilis should also receive anti-syphilitic treatment. *The gummata and chronic syphilitic inflammatory processes which frequently appear, often with fluid in the capsules of joints during anti-syphilitic treatment, probably recover more quickly with than without massage* (Falkson). *Massage is contra-indicated later on if there is necrosis or purulence.*

Fluid in a Joint (*Chronic Serous Synovitis*) is a very common complaint, which every experienced practitioner has seen and treated many times.

Most of these cases have to do with the knee, and throw no light on the pathogenesis; they often occur as the result of trauma. The patient can only say that the joint gradually swelled without drawing his attention to it by causing pain. He feels a very slight disablement, merely a feeling of weight, weakness, and insecurity when using the leg. The joint appears swollen, but is not hot or red. The contour on either side of the patella is changed and the hollow under the tendon of Quadriceps Femoris, indicating the joint, is replaced by fulness. In order to ascertain whether there is any effusion present in the joint the patient's leg must be extended in a lying position. One then presses with one hand on the anterior surface above the patella and so empties the hollow under Subcrureus of its fluid contents, thereby increasing the content of the rest of the joint; then one taps the patella lightly with one hand and observes " riding " of the patella.

This frequently obstinate complaint can sometimes be cured by hard frictions on the anterior part of the capsule, effleurage over the popliteal region, and a bandage, preferably of elastic, worn as long as the joint is under treatment and for some time after recovery. In other cases the joint must be treated by aspiration, injected with

a solution of carbolic or dilute iodine (1 : 3), and when the reaction has passed off must be massaged before complete recovery is obtained.

At this point I feel compelled to go into the intricate question of the distinction between *chronic progressive arthritis*, *chronic rheumatism of joints*, and *arthritis deformans*.*

By the term "*Primary Chronic Progressive Arthritis*" is generally understood nowadays a joint affection beginning, as a rule, at forty to fifty years of age, without fever and chronic. Its development is very slow, and it may appear in many, often in two similar joints, either without or with a small amount of exudation, and with thickenings in the capsule and pericapsular tissue. On placing a hand over the joint (for example, over the knee) while the patient performs movements, one feels a slight grating or crepitation. The disease often begins in the fingers or wrists and in the joints of the foot, and may proceed to attack more central joints, or may only appear in these latter.

Among the cases of this progressive chronic arthritis, which is also aptly termed "*arthrite sèche*," "dry arthritis," the disease affecting both knees, known as "*synovitis crepitans*," is the most common. I have certainly seen and treated more than a hundred cases of this curious complaint, which was formerly often known as chronic rheumatism, and in England and America as "rheumatic gout," in spite of the fact that it has nothing to do with rheumatism or gout. It generally occurs in *fat women*, beginning slowly and insidiously at about forty to fifty years of age. The patient complains of pain and stiffness in *one* knee, especially in the mornings. On examination one always finds that both knees are affected, although one is worse than the other.

Dry arthritis is one of the most important diseases of joints from the point of view of the masseur, because it is very common, because it yields excellent results to hard, but only to hard, frictions, and because it ought to be treated for some weeks every year. It can never be cured. If it is left to itself it often develops into a serious arthritis deformans.

It is well to make use of Bier's bandage, local hot baths and injections of fibrolysin, as well as massage and gymnastics.

Those forms of chronic "dry" progressive arthritis which attack

* I have now considerable clinical experience of these cases, as I have seen them every year for over thirty years. But I will not pretend that I am therefore clear as to the various forms of these diseases. Considerable help towards a knowledge of them can be gained by the study of three recent works: "Arthritis deformans und sogenannter chronischer Gelenkrheumatismus," Albert Hoffa u. G. A. Wollenberg: Stuttgart, 1908; Wullstein and Wilms, "Lehrbuch d. Chirugie": Jena, 1910; and "Studier öfver rheumatiska och rheumatoida sjukdomar," by Israel Hedenius, Om spondylarthritis, Hygiea: Stockholm, 1911.

the small joints of the hands and feet, which are not uncommonly seen on the fingers of both hands as "*arthritis nodosa*" or "*poor man's gout*," are thankless cases for mechano-therapy. They often develop into serious cases of arthritis deformans.

If this progressive arthritis does not attack too many joints, especially if it does not attack the joints of the spine, it does not seriously threaten the general health. If a patient with dry arthritis, by taking massage for a few weeks every year, prevents the complaint limiting her physical exercise too much, she may enjoy good health for years.

If physical exercise is too much limited or altogether prevented, the general health suffers seriously, and the patient's power of resistance is very much lessened.

As far as ætiology is concerned there is no foundation for any theory of infection nor for confusion with the condition following rheumatic fever. In this complaint we have no fever and no endocardiac changes. The complaint is as inexplicable as obesity, from which these patients often suffer before the trouble in the knee has restricted their physical exercise. Suppositions either as to disproportion of the body weight to the strength of the structure of the joints, or changes in the central nervous system, or toxic influences of bacteria in other parts of the body, or rheumatic influences have not hitherto been supported by observations.

In the term *Chronic Rheumatism of Joints* I include, as is now becoming general, the condition following rheumatic fever. In these cases there has always been fever, often frequent attacks of fever, we often find endocardiac changes in the valves of the heart, and the disease occurs as often in men as in women, quite irrespective of age. These points distinguish it from the disease previously described. The disease may occur in childhood or early youth. The pathological anatomy may show great likeness to the above-mentioned non-infectious "dry" arthritis, but in most cases there is considerable exudation to be found in the joint cavity at some stage of the disease. The symmetry is not so pronounced as in the previous disease. But even in these cases thickenings and hyperplasia are to be found in the capsular and pericapsular tissues, atrophic and hypertrophic changes in bone and cartilage; and it not infrequently results in a condition which cannot be distinguished from arthritis deformans as now generally understood.

As a whole the prognosis is better, as far as the joints are concerned, in these cases than in those previously described. As far as general health and length of life are concerned, the prognosis

depends essentially on the presence or absence of endocardiac changes.

It is obvious that differential diagnosis from the disease previously described may be difficult or even impossible. It sometimes happens that chronic rheumatic (secondary) polyarthritis is difficult to distinguish from " gonorrhœal rheumatism " or from joint affections resulting from other infectious diseases. Fortunately the treatment of these affections is similar to that of chronic rheumatism.

The mechano-therapeutic treatment, consisting of massage and hard frictions as well as other means, may often be a severe test of patience for both the doctor and patient, and in the end may still leave much to be desired with regard to functional power. If left alone, or if insufficiently treated, serious contractures or fibrinous or even osseous anchylosis may occur. The last complication does not commonly occur in arthritis deformans, and though not altogether unknown is more uncommon in it than in the disease just described.

Those diseases which begin by attacking the joints and ligaments of the spine deserve special mention here. They very often proceed to attack the joints between the ribs and vertebræ as well as the ligamenta flava, and often even the intervertebral cartilages and all the ligaments. They may also attack the hip and shoulder joints. These diseases also are often clearly of bacterial origin and begin with fever. In other cases we are again confronted with ætiological riddles, and often observe progressive changes similar to those in a non-infectious polyarthritis, frequently leading to deformity.

It was towards the end of the nineteenth century that these diseases became better known, and especially through the publications of Strümpell, von Bechterew, and P. Marie, which I, like most other people, believe refer to these forms.

The disease may begin with or without fever, with or without pain on tapping the spinous processes of the vertebræ, with ascending (Strümpell-Marie) or descending (von Bechterew) stiffness of the spine. There is often anchylosis, often, but not invariably, kyphosis and a straightening of the physiological lordosis, sometimes accompanied by slight scoliosis and more or less severe atrophy of the back muscles. Sensory symptoms and paræsthesia (girdle sensation), neuralgia, and, more uncommonly, motor symptoms (tremblings, jerkings, paresis) may also occur.

In these forms, especially in those cases where movement is very much limited, for example when the hip and shoulder joints are affected, the general nutrition suffers badly, and intercurrent

disease of the heart and lungs or kidneys is liable to cause a fatal termination.

I refer my readers to the works of Hedenius, which have saved me much literary work. He distinguishes in these cases between rheumatic and deforming spondylarthritis and gives the following scheme and summary of his views.

A. Spondylarthritis Rheumatica (Anchylopoëtica).

1. Acute or subacute cases almost entirely localised in the spine.
2. Subchronic or chronic cases of anchylosis of the spine.

a. Only the spine is affected (Bechterew's type).

b. Both the spine and "girdle joints" [hip and (or) shoulder joints] are affected (spondylose rhizomélique, or Strümpell-Marie's type).

c. Rheumatic polyarthritis with primary or secondary localisation in the spine.

B. Spondylarthritis Deformans.

The former variety, which has lately been again described by von Bechterew, Strümpell, Marie, and others, is generally of rheumatic or rheumatoid (toxic) origin, but it may also be caused by serious trauma or by the repeated occurrence of slight trauma. It most commonly attacks men in early middle age, and may be regarded as a more or less local polyarthritis anchylopoëtica or adhesion of the small joints of the spine, and may exhibit all the clinical variations of this disease with regard to the course it takes. The pathognomonic symptom is anchylosis of the spine. The anchyloses occurring in the last stages of the disease produce some conspicuous phenomena (anchylosis of the spine and of the larger joints of the extremities, kyphosis, etc.) which have called particular attention to this form of polyarthritis and caused it at one time to be considered as a disease "sui generis."

Spondylarthritis deformans, which has been known and described for centuries, must not be confused with the above-mentioned disease. As far as we know at present it is not of bacterial origin, is not accompanied by fever, and is generally confined to the lower part of the spine. As a rule the disease is stationary and seldom shows a tendency to spread upward. Anchylosis of the spine is here not a primary, but a secondary phenomenon. The pathological processes are often without symptoms, but may, especially if they are confined to the sides of the vertebræ, cause considerable limitation in the functions of the spine, and also very troublesome pain in the nerves. This disease does not usually attack the extremities.

It is not uncommon, especially if the disease is somewhat advanced, to find intermediate stages between these two principal forms of the disease, just as both diseases probably may appear simultaneously in the same individual. It is on this account that the two diseases have so long been confused both anatomically and clinically.

I entirely agree with Dr. Hedenius that rheumatic spondylarthritis ought not to be treated by massage directly over the small joints of the spine. The articulations between the heads of the

ribs and the vertebræ cannot be affected by massage, and deep friction cannot influence the articulation between the tubercles of the ribs and the transverse processes to any great extent. The whole region of the spine is very tender, and a patient's nervous system may suffer from this ineffectual treatment. In such cases we must content ourselves with prescribing baths and injections of fibrolysin, etc., and with careful passive and active movements of the spine.

As soon as a less painful and tender stage of the rheumatic spondylarthritis has been reached we may treat by massage to counteract atrophy of the muscles. We ought to do this also as far as is practicable in cases of spondylarthritis deformans, but, according to my limited experience of these cases, we must not hope to diminish the kyphosis merely by gymnastics and massage.

By *Arthritis Deformans* * is understood nowadays any affection of a joint which side by side with retrogressive changes leads to real hypertrophy of bone and cartilage, *i.e.*, to rounded knob-like formations, often to atrophy and attrition of other bony parts, and to the destruction of the porous character of the bone, which may lead to an ivory-like hardness. This disease may begin in the cartilage, bones, or soft parts of a joint, and may be mon- or poly-articular. Similar changes may also take place in the cartilage, *e.g.*, in the fibrous rings of the intervertebral discs in cases of spondylarthritis of the spine.

Malum senile (*Coxæ*) is only distinguished from arthritis deformans in that the attrition of cartilage and bone is *more marked* than that which goes on side by side with the processes of hypertrophy in the latter disease.

Arthritis deformans may occur after a trauma as a monarthritis in the larger joints—hip, elbow, shoulder, and others. It may also be the end of a progressive chronic polyarthritis, and is then found in the small joints, *e.g.*, in the fingers in "arthritis nodosa"; it may occur in joints affected with chronic rheumatism and even in a joint which has once been the seat of tuberculosis. The term expresses a pathological anatomical stage of development rather than an actual disease.

The pull exercised by the capsule, ligaments, and muscles on the diseased bones, the force of gravity, and functional influences result in changes of position, with subluxations, deformities, and altered (not merely limited) movement. The muscles are often found to atrophy through inactivity.

It is easily understood that neither massage nor gymnastics can

* The term "arthritis deformans" does not apply to "stalactites," osteophytes, and the small projections formed as a result of any osteitis.

do much good in these cases, although both may well be used to prevent muscle atrophy. Various forms of hot bath may be tried, and Bier's bandage and fibrolysin are sometimes employed. Surgical treatment, especially resection, often has good results, and the same can be said of treatment of the lower extremities by means of irons to take the weight of the body off the affected joint.

It is important to encourage the patient to use the joints as much as possible in all cases of chronic progressive diseases, chronic rheumatism of joints, and arthritis deformans.

Gouty Arthritis is not one of those joint affections for which massage is of great curative value. There is no hope that massage can have any effect on the deposits of uric acid and urates which are to be felt in advanced cases. Massage is equally out of the question when open ulcers are present, and even apart from this it may be harmful through injuring the frequently sclerotic vessels. *On the other hand, it is probable that massage, if used from the very beginning in a case of this sort, can to a certain extent prevent the development of articular changes. Lastly, I have great reason to believe that the typical attacks can be much alleviated by effleurage, and that massaging a joint may keep it free from attacks for a time.* The late Dr. Fogman told me that in six cases of gout he had been able to ease his patients' pain so much by giving effleurage, at first lightly, later more firmly, that though during previous attacks they had been forced to go to bed, they were then able to be up and to move about more or less easily. I was once, with very little hope of good result, almost forced by a gouty German colleague to massage his gouty knees. I do not think there was any doubt about the affection being gout. A boil, which had developed before treatment began, prevented massage over one knee. The difference between the massaged and the unmassaged joint during the next year was, contrary to previous experience, remarkable, and the patient himself entertained no doubts as to the therapeutic value of the treatment.

In certain diseases of the *Central Nervous System*, especially in tabes dorsalis, the joints are often affected to a very serious extent. In tabes it is generally the joints of the lower extremities that are concerned. Many people consider that the changes which take place depend partly on peripheral neuritis and disturbed trophic influences, partly on the too extensive movements and other purely mechanical consequences of ataxy and analgesia combined. It would never occur even to the most undiscriminating advocate of mechano-therapy to attempt to treat the apology for a joint resulting from advanced tabes by massage and gymnastics. In such a joint the movements are abnormally free, the ligaments

stretched and partially torn, extreme hyperplasia is present, hypertrophic and atrophic changes exist side by side, there is a large, often purulent, exudation in the joint cavity, and changes in the bony parts which sometimes affect the whole of the epiphyses. The task of the orthopædist is to see what can be done to alleviate the distress of a patient in this condition. All that can be said in favour of massage is that it may have some prophylactic influence and prevent the above-mentioned changes, or perhaps retard their development in the first stages. I shall return to the subject of gymnastics and massage in the treatment of tabes when I deal with Frenkel's treatment later on.

Neuroses or *Neuralgia of Joints* are affections in which great pain is present in the joints either on movement or at rest, though no pathological anatomical foundation can be discovered. Of late years many cases of what was formerly considered pure neuralgia have been found to be cases of interstitial and parenchymatous neuritis, and in the same way neuralgia of the joints is not so wide a term nowadays as when used by Brodie, and the number of cases has considerably diminished since we have gained further knowledge of certain conditions. These conditions consist of actual changes in the joint, *e.g.*, dislocated semi-lunar cartilage, or the small, but from the clinical point of view often important, circumscribed infiltrations in the capsule, which give rise to striking subjective symptoms (see p. 382). It is clear that these cases cannot be considered as neuralgia of the joint, and it is equally wrong to consider as such those cases in which pain is felt in the joint after inflammation, for the pain is certainly due to infiltrations, adhesions, etc., though these are not easy to show.

True cases of neuralgia in joints are rare and occur in more or less neurotic and psychopathic individuals. In these cases it is as difficult to distinguish between fully conscious simulation and real sensations of pain, which latter may be so severe as to occasion disarticulation of the hip (Pitha and Billroth), as it is to give an opinion as to the value of the different kinds of therapy. These are many, varying from hypnotic suggestion to massage, and may succeed or fail on grounds of which we are, and perhaps always shall be, absolutely ignorant. Let me remind my readers of the variable and mysterious hysterical symptoms other than those affecting joints. One hysterical patient frightened the neighbourhood for years with violent epileptiform attacks, which never failed to yield to a solemnly performed subcutaneous injection of aqua destillata purissima. Another patient who for years was dumb or could only whisper found the muscles of her larynx and her vocal cords in good condition as soon as she felt electrodes touching her

skin, whether they happened to be in connection with the battery at the time or not, and cried out distinctly during the stage of excitement when under chloroform. A third hysterical patient, one of Dr. Bum's, stayed in bed from pain in the knee, suffered intense pain if the joint was merely touched, but could stand energetic massage if she was allowed a trace of chloroform, and was cured in this way. There are many cases of this sort which are healed by pictures of the Madonna or by holy water of different kinds. Massage is not worse than holy water, hypnotism, or the suggestion of personal influence, or pictures of the Madonna, but it depends entirely on the patient's opinions whether it is better than these.

* * * * *

The masseur-gymnast has in most cases to deal with the larger joints. *The knees and ankles are the most commonly affected. The shoulder, elbow, and wrist each provide a considerable number of cases.* The hip is more protected, and except for tuberculosis is not so often the seat of pathological processes or so exposed to trauma. Apart from deformities, especially scoliosis and flat-foot, other joints than those above mentioned comparatively seldom come under treatment.

Apart from the examination of fractures already referred to, a concise reminder as to how an examination should be conducted is necessary for a considerable number of my readers.

After hearing *the history of the illness* and the subjective symptoms one proceeds with *inspection*, and one should make a rule of never neglecting *to compare the affected with the corresponding healthy joint. The colour of the skin* may at once give some clue, *e.g.*, in cases of trauma or of acute, especially purulent, inflammation, such as "white swelling." *The position of the joint* often throws light on dislocations or fractures, and is also characteristic for the different joints when inflamed. Special care is taken to observe the *deviations in form* which are peculiar to each joint when the contents of the joint cavity are increased, and also those produced by thickenings in the articular and peri-articular parts. These deviations in form vary enormously. We all know how obvious, even to the most inexperienced eye, are the alterations in form which appear as the result of a severe wrench, or of fluid in the joint after serofibrinous and purulent, or during tubercular, deforming, and other affections of joints, or after long fixation. On the other hand, every masseur knows how easily the most experienced doctor may overlook the inconspicuous local swelling, which in many cases may denote a circumscribed simple synovitis without exudation in the joint cavity, a so-called "capsulitis," which, especially if it

occurs in the knee, is of such extraordinary importance from a practical point of view This condition was in reality little known or thought of before Mezger enlightened us on the subject. By measuring the *circumference* with a tape measure, or the most variable *diameters* with compasses, a more accurate idea of the changes of volume may be gained. It is of the first importance to note whether and to what degree *active movements are limited.* After this one proceeds with palpation, the most important part of the examination, which as far as possible completes and makes clear the diagnosis. One then tries to gain some idea as to the contents of the joint cavity, chiefly by examining for *fluctuation* in the way which every medical student knows, and which need not be described in detail. By means of pressure and slow frictions, during which it is well to apply a lubricant to the patient's skin, and if need be by constantly comparing with the corresponding joint of the other side, and by observing any *tenderness,* the most accurate knowledge possible is gained with regard to the changes in the soft parts of the joint, especially the capsule. When the capsule is protected by thick coverings this examination is difficult, and necessarily gives less certain results, but in those places which are thinly covered, and especially where the capsule may be pressed against a smooth bony surface, as, for example, a great part of the front of the knee, very small changes and thickenings can be detected.

While one presses the capsule against the underlying bone with the fingers of one hand and with the other performs slow passive movements of the joint, one feels the nature of the synovial membrane as it glides against the under-layer, and can observe when it is normally smooth and even, or if it is " fringed " or granulated, etc., through hypertrophy. During these passive movements as the cartilages glide upon one another further enlightenment is gained as to their nature, as to the changes in them after purulent or " deforming " processes, as to incrustations (gouty arthritis), or as to callus formation after intra-articular fractures, etc., all these observations, if the changes are considerable, being assisted by hearing as well as by touch.

The most important object in performing *passive movements* is to observe the degree of *limitation of movement* (and in doing this the relation of the excursions to those in active movements should be noted) and to find out to what extent such a limitation depends on changes in the articular or peri-articular parts, or in the muscles. The share which the muscles take in this can easily be ascertained by performing the greatest possible passive movements, and by palpating the muscles or muscle groups and tendons at the extreme positions and by observing whether their elasticity is used to the

utmost. When the movements cause severe pain this examination can only be successfully carried out by putting the patient under chloroform and so excluding the influence of the will and reflexes. The examination ought at the very beginning to be as thorough as possible and to extend to every accessible part of the joint. Even when this is done, more or less valuable additions to one's knowledge of the case, sometimes of practical importance, are often gained during the treatment.

In many cases in which bone or cartilage is concerned it is necessary to have the help of *X-ray photography.*

After severe affections of the joints one has first of all to decide, often as a result of the examination, whether it is worth while attempting to restore the functional power of the joint, i.e., if it is possible to prevent a real anchylosis and considerable enlargement of the cartilage. The very smallest amount of movement in the joint decides this question, and such movement can often be discovered round *one* of the axes, though movement round *another* may seem quite impossible, at least at first sight. In examining doubtful cases one performs very small movements in different directions so quickly that the patient cannot innervate the muscle groups in time to prevent them. It is also a fairly sure indication that there is no real anchylosis if the patient shows signs of great pain when one tries with moderate force to produce passive movements in the joint. The pain is not only intimated by the patient ; it is clearly shown by the work of the muscles. To gain as far as possible some idea of the condition of the cartilage one must consider carefully the course the disease has taken, must examine carefully the relative position of the bones in the joint, which is usually changed if there is any considerable enlargement, and must examine the edges of the cartilage by palpation. It is rare for the condition of the cartilage to prevent recovery of functional power if the other parts admit of it.

As a result of tuberculosis or some other purulent process, after long-standing chronic rheumatism or some other severe joint affection involving changes in bone and cartilage, or occasionally after long immobilisation, a real anchylosis, a complete osseous or firm fibrous union between the bones, may be found, and if the position of the joint is fairly convenient it is usual in Sweden to leave it as it is.

In larger civilised countries, where people are bolder in thought and more enterprising in action than we Scandinavians, it is the custom nowadays in many of these cases to perform an *arthrectomy.* To do this the articular surfaces are separated by means of a chisel and saw, and new cartilage is obtained by inserting shaped pads, generally from the subcutaneous connective tissue (which is rich

in fat). The necessary treatment after such operations consists of massage and medical gymnastics. I have no personal experience of such cases, the results of which vary considerably.

I can say equally little on the subject of mechano-therapeutic treatment following the modern method of *transplanting* a piece of bone with cartilage into partially destroyed joints.

As soon as any, however little, power of movement is found in a joint, and as long as no tuberculosis is present (see above), the most important aim of massage and gymnastics is to restore normal, or as nearly as possible normal, movement in the joint.

Every limitation of a joint's normal mobility, from the very smallest to the apparent locking in pseudo-anchylosis, is known as contracture. We distinguish between different kinds of contracture according to the pathological anatomical origin of the limitation. Thus we speak of *dermatogenic contractures* due to shrinking, stiffness and shortening of the skin, of *myogenic contractures* due to changes in the muscles, of *neurogenic* (*paralytic or spastic*) *contractures* when of nervous, whether central or peripheral, origin, of *arthrogenic contractures* when the changes are present in the joints themselves, either in the soft parts (*desmogenic*) or in the cartilage and bones (*chondrogenic* and *osteogenic*).

We always note the position of the joint and (with the late Professor von Mikulicz) speak of *simple contracture* when this is within the normal range of movement, or of *complicated contractures* when the position is abnormal. Genu valgum is thus an example of a complicated contracture.

Another fact to be remembered is that it is usual to distinguish three different conditions with regard to the position within the normal range of movement. First we have the *middle position* in which the tension is alike in all the soft parts It is this position that the patient, through reflex action and therefore quite unconsciously, takes up in acute joint affections, especially if any exudation is present, because it is least painful and because the exudation tends in itself towards a uniform enlargement of the capsule. Meanwhile, if no correction by means of treatment is provided, another position is derived from the first, partly determined by gravity and the patient's (generally lying) position, partly by the atrophic contractures of the muscles which occur at varying periods in the different muscle groups. Thus arises the *actual* position of contracture. Just as this position differs from the middle position, so it also differs from the *desired* or *most favourable* position, by which is meant that position in which the contracture (or a possible anchylosis) causes least inconvenience to the patient. If we consider the position of the foot at the ankle

and tarsal joints, which together determine the movements and position of the foot with regard to the lower leg, we see that the middle position is one of slight plantar flexion at the ankle joint without appreciable inversion or eversion at the (posterior and anterior) talo-calcaneal joints. *The position to be aimed at is that in which the foot is at right angles to the lower leg without inversion or eversion*, and in acute affections where stiffness of the joint is threatened we fix it if possible in this position by means of a splint. If this has not been done we find, both after an ordinary fracture of the fibula and after severe affections with exudation in this joint, plantar flexion and some eversion and the foot pointed outward—in other words, a talipes equino-valgus, which has developed from the middle position, partly through the influence of gravity acting on the patient in a lying position, partly because the comparatively thin peronei have undergone more atrophie shortening than the other muscles.

I omit for want of space the resting positions and the eommon positions of contracture and mention here *the desired positions (for contractures and anchylosis) of the remaining large joints. They are: almost complete extension at the knee, slight flexion, slight abduction and slight inward rotation at the hip, slight dorsal flexion at the wrist, flexion to a right angle combined with moderate supination at the elbow, slight flexion forward, slight abduction and slight inward rotation at the humero-scapular joint.*

Any joint fixed in an *abnormal* position, however slight, should never be treated by massage and gymnastics alone. Such eases belong to orthopædic surgery, and after forced correction or open operation should be fixed and left untouched for a short time, some days only, if there is hope of restoring any power of movement, and for a longer time, some weeks to two months, if there is no such hope and if anchylosis is desired. After the orthopædic treatment massage and gymnastics are used in the former ease to produce as much power of movement as possible in different direetions from the desired position round the normal axis or axes of the joint, and to keep the nerves and muscles in a good state of nutrition.

From the patient's point of view the difference between the most favourable and a less favourable position of contracture or anchylosis and between an entirely lost or moderately limited power of movement is very great. The range of movement also is of great importance. A patient whose foot is fixed at right angles to the lower leg is much better off than one who is left to drag an anehylosed talipes equinus, and a patient who is left half the normal range of movement in the ankle suffers little ineonvenience from his deprivation if he ean

move his foot equally in both directions from a position in which the foot is at right angles to the leg.

Different kinds of contracture call for very different kinds of treatment.

Dermatogenic contractures may arise as the result of large burns of the third degree, which cause widespread radiating scars in the true skin and subcutaneous tissue, more or less deep, and tending to contract by degrees. If the whole of the injured part is treated, preferably as soon after healing as possible, with small but firm frictions, after much hard work sufficient softening without actual breaking down of the scar tissue can be produced to considerably facilitate the performance of passive and active movements, and even to restore a certain amount of mobility.

With regard to the contractures which arise from chronic inflammation and shrinking of the fascia, it is better to point out the extreme difficulty of gaining any satisfactory results by means of massage and gymnastics than to make any rash promises of cure. Billroth's assistant, Barbieri, an excellent masseur, was the first, to my knowledge, to show that good results can be obtained by this method in the treatment of Dupuytren's contraction. But an enormous amount of work consisting of firm frictions and passive movements of the fingers is necessary to obtain these results. It is better to entrust the first treatment of this complaint to the surgeon and only to employ the other methods in the after-treatment.

If a contracture is due to *atrophic shortening of muscles,* massage cannot restore the normal condition even at an early stage of the case, and I am inclined to give a similar verdict in the case of gymnastics. One can certainly *tear* and so stretch shortened muscles, and hasten their recovery by means of effleurage, but this method would be difficult to apply to any but fairly small muscles.* *The best form of gymnastics to lengthen shortened muscles is, without doubt, eccentric movements in the outermost part of the range of movement while the patient gives strong resistance, but even with this method the results are very slow.*

* Some years ago I had an opportunity of showing a case of this kind to some of my colleagues in Stockholm. The patient was an American lady, and is very well known in certain Boston circles. Serious loss of functional power in all four extremities had resulted from too long fixation after extensive injuries in a railway accident. The extensive traumatic myositis in the legs was soon cured, and the power of walking was restored without much difficulty. The fingers of both hands were held in the position of athetosis and could not be bent on account of the shortening of the extensor muscles. I stretched the extensors by means of strong, but at the same time slow, passive movements, and in a comparatively short time removed the swelling and pain from the forearm by effleurage. Functional power was completely restored. The marked limitation of supination of the right forearm was got rid of by a forcible supination, which apparently tore Pronator Quadratus from its attachment to the radius. But here, too, everything went on satisfactorily, although the arm could never be quite fully supinated.

The method of tenotomy lengthens by inserting scar tissue into the tendon in place of the voluntarily contractile muscular tissue, but this is unsatisfactory. The alternative is combined orthopædic, massage, and gymnastic treatment, which is most easily applied if the contracture in question affects the knee or elbow. If, for example, we have to treat a case of contracture of the elbow, in which extension can only be performed to a right angle, we place the joint in this position in plaster of Paris and leave it for about a week. When the plaster is taken off we find that the shortened muscles have been lengthened by their own " tone," as it were, and that extension can be performed a few degrecs further than before. We then proceed to treat the arm with massage and passive and active eccentric gymnastics for about fourteen days. After this we again place the arm, extended as far as possible, in plaster of Paris and continue the treatment of alternate fixation and massage and gymnastics until our aim is at length accomplished. Fixation in extreme positions is painful and involves the use of some soothing drug.

With muscular contractures at the ankle the required right angle, or a certain amount of dorsal flexion, is often most easily attained by walking on sloping ground. Fixation in extreme positions can also be used in these cases when the patient has " worked up " his foot into performing maximum dorsal flexion.

With regard to contractures of nervous origin, I wish to remind my readers that both spastically contracted and weak and paralysed muscles ought to be massaged. Too much and too little activity alike cause disturbances in nutrition of muscles, and one may see contracted muscles after long hysterical contractures just as much atrophied as muscles strained by excessive exercise, or as weak or paralysed muscles may be after such a disease as infantile paralysis. In treating hypertrophied muscles no other manipulation is as suitable as effleurage, for this has the greatest effect on nutrition without being too stimulating.

It is specially in advanced cases of true joint contracture that beginners are doubtful as to whether to attempt forced correction. If by forced correction is understood breaking down a stiff joint by great violence, such an operation in my opinion ought never to be performed. If there are indications in favour of loosening a real anchylosis (a bony or fairly extensive fibrous union between the articular surfaces of a joint), this is better done nowadays by surgical operation than by such coarse and brutal violence as breaking down the joint. In the case of a pseudo-anchylosis or a contracture with minimum mobility it does not require *great* force, when the patient is *under an anæsthetic*, to stretch what can profitably be

stretched, and to produce the amount of movement *which can afterwards be restored by massage and gymnastics.* By once performing these movements under an anæsthetic one gains important help towards the prognosis. Besides this, the performance of the most extensive movements possible, within the normal range of movement, while the patient is under anæsthesia which need not be deep, has great therapeutic value in that it interrupts the development of those changes which result from continued immobility, and considerably facilitates the future treatment by passive movements as far as the patient can endure them. The slight inflammatory reaction which follows such treatment by passive movements assists the absorption, which is one of the objects of massage. The performance without an anæsthetic of more extensive movements than the patient can endure without severe pain is wrong, and causes agony which may seriously affect the patient's nervous system.

Hippocrates in an unguarded moment once expressed the opinion that massage, which is able to make a stiff joint looser and more mobile, is also able to make loose joints firmer, and this little *lapsus linguæ* of the venerable father has for centuries been repeated by mechano-therapeutic specialists, who have always been endowed with far more enthusiasm than critical faculty. "*Loose joints*" consist first of all of *flail joints*, which are most often due to an elongated fibrous union after a resection, or sometimes to strain of the capsule, with paralysis of the muscles, usually at the shoulder in paralysis of Deltoid. A flail joint requires chiefly orthopædic apparatus to limit movement; massage and gymnastics can only strengthen the atrophied muscles. To shorten muscles which are too long by allowing them only to work in the "inner part of the range of movement" is at best a slow process. Our treatment is also rather limited in cases of *stretched capsule.* It can assist absorption of the exudation which caused the stretching, and to a certain extent can lead to greater tension in the capsule by strengthening the muscles. When the looseness of a joint is the result of *torn ligaments*, effleurage is specially useful in assisting rapid and good recovery, the latter also requiring in certain cases (*e.g.*, lateral ligaments of the knee) fixation by some apparatus.

In massage of a joint only two manipulations are generally used, effleurage and friction. Occasionally with chronic sluggish processes, *e.g.*, fluid in the joint, it may be well to make use of tapôtement, for hard tapôtement has a stimulating effect, produces congestion in the whole joint, and makes the processes more acute and so easier to bring to an end. When one wishes to

produce more activity and increased local absorption in a joint after severe inflammation, and when hyperplasia remains, it is better to do this by local treatment with hot baths, either water, sand, mud or air, or by douches, than by tapôtement on a joint, which is often very tender. We ought also to remember Bier's very useful bandage and the *slight* passive hyperæmia resulting from its use, though even now its effects are not universally known.

With regard to effleurage and frictions, it is easy for any one who understands their effects to assign to each its appropriate part in the treatment of a particular case. This merely involves the application of rules analogous to those already stated, perhaps too often, in other parts of the book. *Effleurage is excellent when it is essentially a question of counteracting an acute inflammation, and is therefore of great value in acute serous synovitis and in simple traumatic joint affections.* When these are quite fresh and in the most acute stage and all strong (mechanical) stimulation must be avoided, effleurage applied as light strokings, even over the inflamed part, is *the only* rational manipulation, and is as simple as it is effective. In these cases it should also not be forgotten that effleurage, when applied (as firm strokings) *over the vessels in a central direction from* (not over) the inflamed part, is able to help on the circulation and counteract stasis and inflammation in that part. Even in other cases effleurage should always, without exception, form part of the massage treatment of a joint in order to aid the circulation and thereby promote absorption and local nutrition.

As soon as it is a question of promoting retrogressive changes, the breaking up, and, finally, the absorption of the pathological tissue elements, frictions are the most useful manipulation. When one has to deal with fresh, to some extent organised, masses of connective tissue with the accompanying newly-formed capillaries, deep frictions are applied (generally with the thumbs), whether these capillaries have been formed owing to the inflammatory affection of the joint or owing to the passive inflammation caused by bandages. In these cases, and whenever a strong mechanical stimulation is not dangerous, we apply effleurage more firmly, preferably at the beginning and end of each séance.

There are various other general rules with regard to technique which I should like to recapitulate.

It is always best to begin the séance with effleurage over the vessels, beginning just below the joint and continuing some distance above it. Only in cases when tapôtement seems necessary is a séance begun with this manipulation.

Frictions ought always to begin in that part of the affected tissues lying nearest the centre (of the circulatory system), because what is broken down can be pressed into the lymphatics more easily and with less pain than in the peripheral parts of these tissues, where the tension and resistance in the smaller lymphatics is greater.

Passive movements are performed towards the end of the séance, and are usually followed by effleurage, which removes the resulting irritation and pain and always makes a satisfactory ending.

When the patient is allowed to use local hot baths or douches or Bier's bandage, it is best to massage immediately afterwards, while the tissues are hyperæmic, absorption more active, and the tenderness less than usual.

When atrophy of the muscles or any such tendency is present, which is always the case when a joint has been much limited in its movements for any considerable time, one should never neglect to massage these muscles very thoroughly.

Gymnastic treatment is an important accessory to the treatment of many joint affections which require massage, but should not be used side by side with massage under all conditions. Movements are injurious during the most acute stages of an inflammation in a joint, because they increase the flow of blood to the joint (*as to any organ which is brought into activity*) *and so encourage the inflammation.* The beneficial effect of movements in helping the circulation can never counterbalance the above harmful effects, but this can, especially in some joints, be compensated for by effleurage. May I say as a reminder to many of my countrymen who want to use gymnastic treatment in season and out of season that immediately after sprains, contusions, reduction of dislocations and after fractures, and with acute synovitis of all kinds, rest is indicated and any movement contra-indicated. As the symptoms of inflammation begin to disappear the patient may be allowed to begin using the joint and to use it gradually more and more. This usually takes place in a few days, at the most fourteen days, after any trauma not involving fracture, and so before the rest has had time to cause any serious disturbance.

In treating severe affections of joints one's object, viz., to restore to the patient a fairly useful joint, is only attained little by little by daily energetic treatment week after week, or perhaps month after month, and one must not lose hope if at first this seems difficult or even impossible. In some cases one finds hardly any visible power of movement in the joint, the external form is effaced by masses of new connective tissue or by hard cellular œdema with marked plastic tendency, the capsule (as far as can be ascertained

by palpation) is extremely infiltrated and much thickened, the muscles atrophied and, worst of all, perhaps more or less shortened, and a great part of the extremity often colder than normal owing to the bad circulation. The aim and method of treatment in such cases are to remove the inflammatory products from all the tissues (especially the capsular and pericapsular) and help on the circulation by applying deep frictions and effleurage ; to prevent atrophy of the muscles by using every kind of manipulation as well as orthopædic treatment, which is the best means of stretching muscles as well as other soft parts when contracted ; gradually to increase the mobility of the joint, stretch or tear adhesions which have been formed, and set free the tendons which have become firmly attached to their sheaths by means of passive movements given by suitable contrivances (*i.e.*, as far as this can be done without lowering the patient's strength by excessive pain and without causing a new inflammation, and just so far as massage is able to restore the tissues to a normal condition) ; to make use of systematic active movements as soon as sufficient mobility has been attained ; at the same time to make use of various local baths, douches, Bier's treatment for stasis, injections of fibrolysin, etc. ; lastly, to remember to treat the general condition if this is in need of it. All this forms one of the most delightful and interesting problems for the doctor-masseur, and its satisfactory solution requires no little knowledge and experience, and still more tact, energy, and perseverance. The results, however, are often far better than could ever have been expected by those who have not experienced what a thorough rational mechano-therapeutic treatment can effect.

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The *Shoulder Joint* is often the seat of trauma, and, especially at clinics attended by manual workers, many such cases are found, generally contusions and dislocations.

Contusions usually affect the anterior and external part of the shoulder, and one can then feel obvious circumscribed muscular swellings in Deltoid, sometimes even small hæmatomata. Sprains are more uncommon than dislocations. Of the latter the subspinous is rare and the subclavicular rather uncommon. The subcoracoid and subglenoid dislocations are together more numerous than all other dislocations in the body put together. The most common fracture is that of the surgical neck.

Metastatic and other non-traumatic joint affections are comparatively rare, although cases of fluid, chronic progressive arthritis, bacterial inflammation, deforming processes, and gout do occasionally occur. Tuberculosis is rare.

Nervous contractures at the humero-scapular joint of central origin or due to affections of the brachial plexus are rare.

In examination of these cases the exclusion of fracture presents more difficulty than usual. The uncommon fractures of the acromion, of the spine of the scapula, and the tip of the coracoid process (tenderness on pressure) are easy to detect, nor should the neighbouring fracture of the clavicle present any difficulties. The common fracture of the surgical neck of the humerus should not be missed in a fairly careful examination. Fractures of the anatomical neck and impacted fractures near the joint, on the other hand, are more difficult to diagnose, and fractures of the tuberosities immediately outside the joint are often overlooked. Fractures of the lesser tuberosity are certainly rare, but, on the other hand, it is not at all unusual for the whole of the greater tuberosity or the part round its anterior facet, where Supraspinatus is inserted, to be detached. It is not to be expected that palpation can give any decided information here. In such cases considerable swelling both in the transverse and sagittal directions is common. A circumscribed tenderness on pressure often gives the right clue. When the whole of the greater tuberosity is separated it can be felt under the acromion, and is pulled strongly outward, even somewhat backward, while the head of the humerus is dragged inward and can be felt close to the coracoid process. If one suspects that the anterior facet is torn off, this suspicion is increased if when the patient's arm has been abducted to the horizontal position he feels a sharp localised burning pain in the joint when he tries to hold his arm up by his own innervation. Rotation is also painful.

A good skiagram is highly desirable in these cases. If fracture is present massage should not be begun before the joint has been properly fixed for at least a fortnight.

The most marked swellings caused by effusion in the joint are to the front and still more to the back below Deltoid, less in the axilla. In these cases rotation is limited, but the arm is rotated somewhat inward. If the outline of the shoulder bulges outward it is generally the result of a swollen subdeltoid bursa, sometimes of fluid in the joint. If there is a swelling of the acromial bursa it shows more to the front under Deltoid. A swelling in the bursæ of Grube can be seen near the coracoid process. Abscesses in the connective tissue or in the lymphatics of the axilla must not be mistaken for inflammation of the shoulder joint and massaged.

It must be remembered in regard to non-traumatic inflammatory affections of the shoulder, especially of bacterial origin, that they often develop so insidiously that functional disturbances have

often reached an advanced stage when the patient comes under treatment. I have seen many such cases, especially after the recent epidemics of influenza. The patient has felt a dull pain in the joint which he has put down to ordinary rheumatism, and which has made him, partly unconsciously, perform the movement of abduction as far as possible by rotation of the shoulder blade and, especially if the left arm were the one affected, use the other arm in place of the affected one.

In examination of movements in the humero-scapular joint it is important to distinguish clearly between those movements which take place in this joint and those which take place by means of rotation of the scapula on its antero-posterior axis. One stands behind the patient, grasping the lower angle of the scapula with one hand, and with the other grasps his elbow and performs abduction in the shoulder joint. Normally, as we know, abduction can take place to a horizontal position, but anything further than this is effected, even normally, by rotation of the scapula. When there is any inflammation in or round the joint the patient can easily fix the humerus at the shoulder joint by innervating his muscles, and on examination one gains the impression that mobility is reduced to its minimum or is completely lost. In such cases, especially in the case of the shoulder joint, great diagnostic, prognostic, and therapeutic advantages are to be gained from the use of anæsthetics, and their use should not be neglected. A novice often marvels at the great ease with which movement is obtained without perceptible resistance within a large part, if not the whole, of the normal range. In other cases one can certainly feel how one stretches the shrivelled capsule, or tears asunder adhesions in its lowest part, when one slowly but firmly brings the upper arm up to the head.

The treatment of the shoulder joint is partly dictated by the tendency of the shoulder muscles to atrophic shortening. As soon as it is possible to perform passive movements—a few days after contusions, sprains, the reduction of dislocations, and as soon as the first stage of the healing of a fracture has taken place—one must endeavour before all else to bring the arm both forward-upward and outward-upward to a position behind the head. Every patient with inflammation of the shoulder, of whatever kind this may be, is in great danger of losing this part of the normal mobility of the joint. The corresponding contraction develops quickly and easily for two reasons. One reason is the already-mentioned tendency of some of the muscles concerned, especially Teres Major and Teres Minor, rapidly to undergo atrophic shortening. The other reason is the adhesive synovitis which in the shoulder joint causes adhesions of the folds in the lower part of the capsule anteriorly

and posteriorly. Owing to the ordinary position of the arm it is the lower part of the capsule which is shortened by shrinking.

In some dislocations the circumflex nerve is injured. The Deltoid is then occasionally paralysed, and sensory symptoms may also arise.

The important movement of raising the upper arm to the side of the head is best performed when the patient is in lying or half-lying position on a plinth. After this movement he may stand and take *adduction forward*, which is done by carrying his elbow as far as possible towards the pit of the stomach. Lastly, *adduction backward* is performed by grasping the patient's fully pronated forearm and carrying the elbow backward as near to the spine as possible. If arm-lifting-upward can be performed fully when one leaves off treating the patient, some one in the patient's home can be shown how to carry out the movement, and the patient can practise it himself several times a day by taking the " hanging fundamental position " of Swedish gymnastics as well as he can.

It is after dislocations of the shoulder joint that one most often finds that the dislocation was not reduced soon enough and that it is no longer possible for it to be reduced. The latter may even be the case after two months, in spite of the accounts published of reductions after a year or even longer. In such cases one must try by means of massage and gymnastics to make the most of the false joint formed, and it is possible, especially in subcoracoid dislocation, to obtain very fair mobility.

The *Elbow Joint* is very often the seat of trauma, especially in the icy land of Sweden (in which, moreover, at least half the working population are every now and then unsteady on their legs through drink).

Severe contusions of this joint are common, and in such cases it is not unusual to find it distended with blood, which shows itself later on as large hæmoglobin-coloured patches in the subcutaneous tissues of the upper arm. Even if a fracture cannot be diagnosed in a case of this sort there is very often a partial fracture.

The only common dislocation, of both ulna and radius backward, requires massage immediately after reduction if the coronoid process is not broken off.

The transverse fracture of the lower part of the humerus, with displacement backward of the lower fragment, the T-shaped partially intra-articular fracture, and other fractures in or near the joint, are all easy to detect. This is especially true in cases of fracture of the olecranon, by no means an uncommon fracture, if only one remembers to search for it by careful palpation of the usual place, about an inch below the upper edge of the olecranon.

Fracture of the Olecranon is the only major fracture for which treatment by massage and gymnastics alone can, under certain conditions, *i.e.*, with minimum effusion, be defended. In such cases one gives effleurage and frictions preferably twice a day, and soon begins with quite small movements of flexion, which are by degrees cautiously enlarged, always provided that the effusion between the fragments is not increased. If the fracture is not compound and the effusion is slight, a bony union may often be produced, which is greatly assisted by effleurage. Healing then begins in the outer parts of the fracture and proceeds slowly inward.

Surgeons are, however, fairly unanimous in the opinion that under all conditions the best and surest way of dealing with fracture of the olecranon (as with fracture of the patella) is by suture. Eight, or at most fourteen, days after this operation massage and careful flexion may be given. During the period of fixation some doctors use different splints one after the other, which fix in different positions, from almost complete extension to many different degrees of flexion.

Effusion in this joint shows best from behind by a bulging on either side of the tendon of Triceps.

Tuberculosis in this joint is not uncommon, nor is arthritis deformans; but, on the other hand, gonorrhœal synovitis rarely affects the elbow joint.

In giving frictions it is easiest to get at the joint on the outer and inner sides of the extensor and flexor tendons and through Anconeus. When necessary the accessible part of the annular ligament and the joint between the head of the radius and ulna are worked upon. In treating this complex joint by gymnastics one must not omit pronation and supination as well as flexion and extension, and in fracture of the olecranon one must not begin too early with free flexions.

A convenient arrangement is for the masseur and patient to sit opposite each other during treatment, one on each side of the plinth.

It should be borne in mind that the anatomy of this joint is very favourable for treatment by stasis or by heat.

The *Wrist*, or rather the upper and lower carpal joints, except in cases of sprain due to excessive palmar flexion, which are not uncommon and are easily cured, generally comes under treatment as a result of the typical fracture of the radius. Dislocations of the wrist are exceedingly rare.

Fractures of the Radius, where a perfect reduction with the best possible correction is specially desirable, provide a good opportunity of comparing the value of different kinds of fixation appa-

ratus. If plaster of Paris is used, as sometimes happens, shortening of the muscles, serious shrinking of the capsule, and severe disturbances of function often result. When the ordinary pistol splint is used, which only reaches as far as the heads of the metacarpal bones and so allows flexion and extension of the fingers, and which in its simplicity forms the very best support for these fractures, it leaves after the usual three weeks, if it has been properly applied, a condition which is easily restored to the normal. Progress is still more satisfactory if eight days after the splints are put on they are taken off twice daily while a little careful effleurage is applied to the whole of the lower arm. When the splints and sling are removed altogether fourteen days later the fractured part is quite firm and function is practically normal. At the most but a few treatments with frictions and passive movements are necessary to bring about complete recovery rather more quickly than would otherwise be the case.

In arthritis deformans and various forms of paralysis the joint takes up a position of ulnar flexion, sometimes with subluxation. Not much can be done by massage and gymnastics alone in these cases, but after surgical operation mechano-therapeutic treatment may restore to the patient a quite valuable joint.

During the treatment the masseur and patient sit opposite each other, one on each side of the plinth. Neither in massage nor gymnastics do we distinguish between the upper joint of the hand (the radiocarpal joint, the regular ellipsoid joint between radius and ulna on the one side, and the scaphoid, semilunar and cuneiform bones on the other) and the lower joint of the hand (the irregular ellipsoid joint between the three latter bones, and the trapezium, trapezoid, os magnum, and unciform). On the palmar and dorsal surfaces one gives frictions which extend over both joints, and when the masseur, with his fingers inserted between those of the patient's hand of the same side and with his own and the patient's elbows supported on the plinth, gives passive movements, palmar and dorsal flexion, radial and ulnar flexion, and circumduction take place in both joints, though their axes do not coincide, but form an acute angle with one another.

When atrophic shortening in the extensors of the fingers hinders flexion, it is possible, by means of strong slow flexions involving partial tearing of the extensors, to stretch them to their full length and then by effleurage on the dorsal surface of the forearm to assist their recovery.

The *Hip* comes under massage treatment more rarely than any of the other large joints. Before beginning such treatment it is of the first importance to make sure that no tubercular coxitis is

present. The differential diagnosis is important. When the joint does come under massage treatment it is generally for the results of fracture of the neck of the femur, but as regards this subject I refer my readers to surgical text-books. The more advanced in years the patient is, the more probable it is, as we all know, that fracture of the neck of the femur is intracapsular, and then often does not unite. Intermediate forms are found in which the fracture is partly intracapsular, partly extracapsular. But I must point out that it is not uncommon to find patients in whom fracture of the neck of the femur has occurred when they were well advanced in years and which has healed nevertheless. In any case one treats such joints with frictions in front just below and internal to the anterior inferior iliac spine, going backward in an arched line which begins about midway between the anterior superior iliac spine and the highest point of the great trochanter, and ends somewhat above a point midway between the small trochanter and the ischial tuberosity. One tries all the time to keep rather nearer the trochanter than the above-mentioned parts of the pelvis.

In giving passive movements to elderly people one must always bear in mind how very brittle the neck of the femur may be, and how very easily it may be fractured.

With effusion in the joint the swelling is best seen from the front external to the femoral artery.

After dislocation (and reduction) of the hip one has always to devote oneself to energetic treatment of the muscles, which are often severely torn and bruised. After dislocation into the obturator foramen, Pectineus and the Adductor muscles, especially Add. Brevis, are severely strained and slightly torn. After dislocation on to the pubis the Adductors have generally fared worst. After dislocation on to the dorsum ilii or on to the ischium, the Gemelli, Obturators, Pyriformis, and Quadratus are torn, Pectineus strained, and the Glutei often bruised ; Obliquus Externus, Sartorius, and Ilio-psoas may also be strained and partially torn. As far as one can get at them one must give frictions over the infiltrations in these muscles, and must begin and end each séance with effleurage over the femoral vein, especially over its upper part near the saphenous opening.

An important point before beginning massage treatment is the differential diagnosis from tubercular effusion by the exclusion of hereditary tendency, the tubercular diathesis, rise of temperature, and by extracting fluid from the joint, which in tuberculosis is opaque instead of purely serous.

The *Knee Joint* provides the masseur with an enormous amount of work.

Among the non-traumatic affections tuberculosis is very common, and as long as it is present as such is a *noli me tangere* for the masseur. When there is hope of restoring mobility after other metastatic inflammations of the knee it means very hard work for the masseur.

The chronic serous synovitis with copious exudation, *hydrarthrosis or fluid in the joint*, is a common and rather obstinate affection which has already been referred to.

The extraordinary, rather rare, affection known as *intermittent synovitis* has been treated by massage, sometimes with and sometimes without success. I have had experience of both. *Intermittent hydrarthrosis* is not a very suitable name, since the attacks which occur at varying intervals, generally of over a week, usually accompanied by symptoms of the nature of migraine, are characterised rather by considerable swelling of the capsule and the neighbouring periarticular tissues, especially above and at the sides of the patella, than by effusion into the joint cavity. The affection is probably partly a vasomotor neurosis, and it is very uncertain whether treatment by massage is of any use. In, however, one case the symptoms in the neighbourhood of the joint were gradually reduced to a minimum *during* massage treatment, whereas the other symptoms (headache, sickness, and nausea) remained as before.

By no means such a thankless task is the treatment of the "*circumscribed capsulitis*" already referred to, a serofibrinous infiltration in the wall of the capsule without any exudation into the joint cavity. It is an affection which the masseur should always bear in mind. Though on examination the only sign may be a scarcely visible and scarcely palpable thickening on either side of the ligamentum patellæ or patella and a few frictions applied at the right spot are able to effect a cure, yet it may force the patient to use crutches for years and make him practically a cripple. Even when the patient has experienced such discomfort from capsulitis, he has generally used his muscles sufficiently to prevent the tiresome contractions due to their shortening, and when the infiltrations are removed recovery is practically complete. Some of the wonders most talked about which are wrought by massage are those having to do with the treatment of circumscribed capsulitis.

Synovitis crepitans has also been already referred to. Even if it cannot be completely cured, there are cases which profit considerably in which considerable mobility can be restored and maintained, though only by an enormous amount of work with frictions on the capsule and surrounding parts (the treatment being repeated for a few weeks every year). This also applies to those cases in which the mobility of both knees has been reduced to a few degrees, provided that the patient's general health is fairly

good and that the changes occurring in old age are not too far advanced.

Of joint injuries the only ones of sufficiently common occurrence to be worthy of mention are sprains of the knee, dislocation of the patella, and dislocation of one of the semilunar cartilages.

Of these it is only *sprains* which can be said to be of common occurrence. These are combined with strain of the internal or external lateral ligament. In such cases one can feel a more or less distinct swelling on the inner or outer side of the joint, and on palpation the patient is aware of tenderness. There may be a very tiny exudation into the joint cavity, but this is generally absent. If the case comes under proper massage treatment immediately after the trauma, recovery is generally complete in quite a short time.

If either of the lateral ligaments is badly torn or detached from its insertion on the epicondyles of the femur or tibia, so that abnormal lateral movement can be performed, it is the custom in Sweden to fix the joint for about fourteen days to insure healing and a normal position later on. This is opposed to our usual treatment in dealing with sprained ankles. After this fortnight's fixation, massage and gymnastics easily restore complete mobility.

Among the various forms of *dislocation of the patella*, displacement due to some strong force from without is the most common (even if we except habitual dislocation, which is fairly common, especially with genu valgum). In this case the patella sometimes rotates on its vertical axis, so that its inner edge, or even the whole of its inner surface, is directed forward, the outer edge resting on the external condyle of the femur. In such dislocations Vastus Internus is always severely strained and somewhat torn from its insertion, and the capsule is often considerably torn.

Massage after reduction is a great help towards restoring normal conditions.

The masseur sometimes meets with cases of *dislocation of the semi-lunar cartilages.* The pathological anatomy of these affections is well known now that innumerable cases have been operated upon.* Dislocation of the inner meniscus is the more usual, and is combined with more or less extensive tearing and breaking of its insertion. The displacement may be inward towards the joint or outward ; in the former case a depression, in the latter a bulging, can be seen at the articulation. Dislocation is probably brought about by a violent rotation of the tibia combined with a certain

* See, for example, Ferd. Schulze, " Arch. f. Orthopæd. Mekanoth. und Unfallschirurgie," 1903. " Om traumatiska meniskrubbningar i knäleden," Emil Bovin. Akad. afh. ; Upsala, 1903.

amount of flexion, outward rotation causing dislocation of the inner, inward rotation causing dislocation of the outer meniscus. After the dislocation the patient suffers continual pain, keeps the leg somewhat flexed at the knee, can flex it further, but cannot extend it. The diagnosis of this affection as distinguished from a foreign body is made from the history and by palpation, in which the dislocated cartilage is felt to be fixed and the symptoms are localised to its area. A foreign body, on the other hand, may easily be moved and appears in different parts of the joint, and the pain and tenderness vary in position accordingly, but are lessened or increased by movements.

Some doctors treat dislocation of a meniscus surgically either by removing the dislocated meniscus or by suturing it.

It is still usual in many places, however, to use other methods, and nowadays the method introduced by Bennett seems to be considered the best.

This treatment requires first of all the replacement of the dislocated cartilage. This is done by flexion of the already somewhat flexed knee, combined with inward rotation if the inner meniscus is displaced, but outward rotation if the outer meniscus is concerned, followed at once by extension. After reduction has been effected in this way the limb is put into plaster of Paris from the thigh to the malleoli, and the patient is kept in bed for fourteen days. When half this time has elapsed the plaster case is converted into a capsule, preferably by cutting along both sides, and the joint and muscles of the upper and lower leg are massaged and effleurage is applied to the whole limb. Bennett begins cautious passive movements after the first week. If massage is given twice daily there is no danger of loss of functional power in the future and thorough healing is assured. During the third week the patient may be allowed to be up with the plaster capsule still on. After this a bandage may be used or may be unnecessary, and massage and movements are continued until normal mobility is restored.

Of the fractures affecting the knee that of *the patella* is the most common. If one does not make sure that firm union between the fragments is effected a long connective tissue union is formed, resulting in uncertain jerky extensions of the lower leg and inability to control flexion. For these reasons we have not in Sweden adopted Mezger's proposal, that in the case of patellar fractures massage and gymnastics * should be begun at once, without aiming at the short, firm, if possible, bony union between the fragments.

Nowadays one always tries to produce short, firm, if possible, bony union between the fragments. The treatment originated by

* Rossander and Berghman, " Hygiea," 1879.

Scheele in 1879 is sometimes used to effect this. Here the knee joint, which is generally distended with blood and exudation, is first washed out with a trocar of large calibre, then the upper fragment is drawn down and the lower drawn up, and the two are fixed against each other by long strips of strapping, 3 cm. broad, placed so as to overlap one another like the tiles of a roof. Over this is applied first a flannel bandage and then light plaster of Paris. The whole is replaced for careful observation every week for six weeks, the limb being extended all the time, and for several (four to six) months the patient has to wear a splint which only allows 20° of flexion. At this stage the joint and muscles concerned are treated with massage, and gentle passive and active flexions form part of the treatment. In this way a short, firm fibrous union is always, and a bony union not uncommonly, produced, but disturbances in functional power last long on account of contractures, and it is uncertain whether normal flexion can be restored.

The modern tendency to suture fragments after a fracture when it is found difficult to promote bony union between them is of special importance in cases of patellar fracture. Most surgeons have given up all other methods and now employ suture of the fragments, and if need be of the lateral ligaments as well. After eight to ten days the sutures are removed, and even at this point effleurage may be applied to the muscles. Healing, however, takes four weeks, during which time the limb is fixed in an extended position, but the fixing apparatus is taken off every now and then so that massage may be given, and small gentle passive movements are given after the first fourteen days. In most cases quite useful mobility results.

In massage of the knee the anterior portion of the capsule is the most accessible for frictions, and it is also in this part that the changes due to trauma are generally situated. *But here I must remind my readers that effleurage can only produce its beneficial effects on nutrition and absorption and its antiphlogistic effect on the knee joint when applied at the back of the knee, for it is in that part that the five arteries and their corresponding veins which carry the blood to and fro pass in and out.*

In massage of the front of the knee the best position for the patient is half-lying position on a plinth; in effleurage of the back of the knee forward-lying position is the best.

With regard to *Affections of the Joints of the Foot* I shall here state what is essential with regard to *sprains*, *fracture of the fibula*, and *fracture of the fibula and tibia* just above the malleoli.

I feel impelled to say a few introductory words on the mechanism of the foot, about which there are many false impressions, partly owing to

the complicated nature of the question, and partly owing to the custom that exists both in writing and practice of evading difficult questions. All will remember that the ankle joint is a ginglymus joint where dorsal flexion is combined with a certain degree of eversion, and where plantar flexion is combined with some inversion, and that with plantar flexion when the narrower posterior part of the upper surface of the astragalus is in contact with the tibial articular surface small movements in other directions can take place. Apart from this older physicians must give up their rooted idea that there is a *lower foot joint*, and must grasp the fact that there is a *posterior joint* (*posterior talo-calcaneal*) between the concave under surface of the body of the astragalus and the posterior convex upper surface of the os calcis, and that this joint is a rotatory joint, which controls and always takes part in eversion and inversion. The joint between the lower articular surface of the head and neck of the astragalus and that of sustentaculum tali and the anterior portion of os calcis (*anterior talo-calcaneal*) is quite a separate joint from the former, and is a very irregular and variable one, in which the articular surface of astragalus is slightly convex and that of os calcis slightly concave. This joint has a capsule in common with the *talo-navicular joint*, the joint between the convex articular surface of the head of the astragalus, and a concave articular surface composed of the concave surface of the navicular and part of the inferior calcaneo-navicular ligament. This joint may be considered as belonging to either of the nearly related classes of joints known as arthrodia and ellipsoid joints. The movements of this joint are, however, limited in that, although separated from the calcaneo-cuboid joint by its own capsule, it forms the medial part, whereas the calcaneo-cuboid forms the lateral part of a joint which functions as one. The calcaneo-cuboid joint is considered by some to be an amphiarthrosis, by others to be a saddle joint. The functional joint formed by the anatomically separate joints above mentioned is called, as we all know, the *transverse tarsal joint*, or *Chopart's joint*. The central articular surface of this joint is convex forward medially and concave forward laterally. Chopart's joint as a whole is now regarded as acting like a ginglymus or hinge joint on an almost vertical axis, so that the foot can be pointed outward (abduction) or inward (adduction). Movement in this joint is always combined with movement in the anterior and posterior talo-calcaneal articulations, so that with eversion, when the outer border of the foot is raised, the foot is pointed outward, and with inversion, when the outer border is lowered, the foot is pointed inward.

Sprained ankle is generally the result of violent excessive inversion, and comparatively seldom the result of violent eversion. It is worth while to consider in which joint the excessive movement takes place, for example in inversion. A great many doctors answer at once, and with assurance, in the ankle (talo-crural) joint. From the above many would be inclined to think, first of all, of both the lower joints of the foot, especially the posterior talo-calcaneal joint, since it is essentially in these joints that the normal, rather limited, movement of inversion takes place. Though inver-

sion in the usual position in which a sprain occurs does not take place at the ankle, it does not follow that this joint may not be severely strained; we often find sprains even of the lateral ligaments of the knee. The fact that it is so usual for the ligaments on the outer side between the fibula and os calcis to be torn gives us no clue; they would be stretched whether the sprain occurred at the ankle or at both the joints between the os calcis and the astragalus. That the anterior talo-fibular ligament is so often torn points decidedly to a sprain in the true ankle joint. The short calcaneo-talar ligament in front of the sinus tarsi also sometimes gives the impression of being stretched or torn. A thorough examination often shows that both the ankle and posterior lower foot joints are injured, in other cases the anterior one is tender; nor is it uncommon also to find both the joints forming Chopart's joint very tender on pressure. The greater part of the inflammatory products due to excessive inversion are found in front and on the inner side of the external malleolus. Partial *fracture* (fissure) is found occasionally; * complete fracture less often.

Sprained ankle is the injury which in our day has been of most assistance in leading the general public to believe in massage, owing to its speedy and assured results and its lessening the unnecessary use of tight bandages. At the same time it was this injury which settled, in favour of rest, the old dispute as to whether movements ought or ought not to be allowed in acute joint affections.

In the middle of the nineteenth century the treatment of a sprained ankle consisted in keeping the foot raised and at rest, the use of ice-bags and more or less tight bandages, the latter often being continued for many weeks until all pain had vanished from the joint. This treatment lasted on an average about a month, and not uncommonly occasioned long continued functional disturbances.

The modern treatment, which takes about one-third of the time of the old treatment, and which gives better results, consists in keeping the foot raised and at rest, ice-bags during the most acute stages of the inflammation, and effleurage, given preferably twice a day for the first few days after the trauma, during the acute reaction. This manipulation is continued until recovery is complete, frictions being added by degrees as absorption goes on. All parts which a thorough examination of the joints referred to above shows to be inflamed owing to the sprain are treated by massage.

* I expect some of my readers are astonished at my lengthy description of a sprained ankle. This is, however, one of those everyday occurrences which are so common that they are little studied. It is worth while studying the subject thoroughly.

In most cases friction should be given chiefly above the sinus tarsi on the inner side and in front of the external malleolus. Bandages of all kinds are excluded.

In somewhat severe cases, which are those which most often come under a doctor's care, the treatment is begun immediately after the trauma, seldom lasts longer than fourteen days, but is longer in proportion to the time which has elapsed between the trauma and the beginning of the treatment.

According to the treatment by Swedish surgeons of *ordinary fracture of the fibula* immediately above the external malleolus, the limb is first fixed for fourteen days in plaster of Paris, and during the following week the patient, with his limb still in plaster, is allowed to be up and to use his foot. The object of this treatment is to assure healing and to maintain the normal position of the foot. The method of Mezger's school was to use only a bandage, without massage, and to allow the patient to walk about a few days after the trauma. This treatment was recommended in Sweden about 1870, but has rightly been abandoned, as it was not successful in preventing the position of eversion and abduction, in other words, the essential changes in flat-foot, threatened after these fractures.

In *fracture of both tibia and fibula* the treatment with plaster of Paris is the same, but lasts about twice as long. After two or at most three weeks the plaster, which has been converted into a capsule, is removed daily so that effleurage and graduated gentle passive movements may be given. It often takes a long time to remove the products of the active and passive inflammation in the tibio-tarsal joint and round the tendo Achilles by means of hard frictions and effleurage. The use of the joint, especially walking on slopes of varying steepness, is the best form of gymnastics at the end of the treatment.

In effusion in the ankle joint an elliptical protuberance appears on either side of the extensors. With metastatic inflammation in this joint the neighbouring joints also easily become inflamed. If the joint has not been kept in a right-angled position (by means of von Volkmann's splints) the atrophic contraction is generally greater in the peronei than in the calf muscles and the foot assumes the equino-valgus position. The best gymnastic treatment for producing the valuable right angle between the foot and lower leg is, if anchylosis has not developed, to allow the patient to walk up gentle slopes as soon as possible after healing.

Chronic progressive polyarthritis, secondary rheumatic inflammation, and arthritis deformans are not specially uncommon at the ankle and both the lower talo-calcaneal joints.

In giving massage and gymnastics of the foot it is most convenient to have the patient in half-lying position on a plinth. In giving plantar and dorsal flexion, among the passive movements the masseur must be careful when grasping not to press *unnecessarily* hard on the ball of the toes, which is often tender. The grasp for this movement is obvious. If necessary, one must not omit passive inversion and eversion, grasping the lower leg above the malleoli with one hand, with the base of the other hand pressed against the foot below the external and internal malleoli.

* * * * *

It is of the greatest importance that doctors when treating joints by massage and gymnastics, as with other forms of treatment, should not confine themselves to this treatment alone. This fault is constantly being committed by some who have made a speciality of this treatment, with the result that they are in fact ignorant of all else. I therefore take the liberty of reminding my readers "as delicately as possible" that, especially in joint affections and apart from surgical treatment, we have a great many other methods which are not at all to be despised.* Many of these aim at producing local changes in the circulation, especially passive or active hyperæmia.

Ice-bags are only used in acute inflammation and in traumatic and other acute forms of synovitis. They undoubtedly help to soothe pain, and under some conditions have the antiphlogistic effect generally attributed to cold. Their first effect is to produce contraction of the blood vessels, with consequent anæmia. Without going into the complicated question as to how deep this influence extends or where the corresponding hyperæmia begins, I may mention here that Bier considers the hyperæmia resulting from the use of ice-bags as being passive hyperæmia, and we Swedes who often see face and hands "blue with cold" are inclined to agree with him.

Cold compresses (*Priesnitz*) should consist of a wet linen compress surrounded by a layer of waterproof material. Their effect is to soothe pain and by causing hyperæmia to promote absorption. These effects are due to their physical properties, and I have difficulty in believing in the value of the various salts which some people put in the water.

Local hot water, sand, and mud baths are used to promote absorption only

* I have excluded various treatments of subordinate importance, among them, first and foremost, the now generally abandoned blood-letting, as well as cauterisation, blister, plaster, and ointment of all kinds. Mercurial ointment, which in other respects has been of such enormous service to mankind, I exclude here, as it is somewhat less generally used now, except in the treatment of syphilitic affections of the joints. Troublesome and unpleasant cataplasms have been superseded by warm water compresses, or by local baths of hot water, sand, light, air or mud, which are better in all respects The everlasting tincture of iodine, so highly thought of by many, has its value, but ought not to be used at the same time as massage, because it makes the skin unfit for this much more efficacious treatment. The fact that some authors recommend electricity applied directly to the joint makes it easier for me to confess that I too have tried it at one time in such cases, where, according to my opinion, whether as galvanic or faradic current, it is a mere farce. Its value in the treatment of the muscular paresis which often follows cannot be questioned, but even here mechano-therapy gives such obviously better results that one who is well acquainted with it is tempted to ignore electricity.

after or during chronic torpid processes, and are excellent treatment much less generally used than they deserve. The water baths can easily be arranged in any house, as is also the case with the more uncommon sand baths. Mud baths, which are really better, can rarely be used except at watering places. The effect of these baths is due to their thermic properties, and the benefits derived from them depend entirely on how they are given. I usually recommend my patients to take them as hot as they can comfortably bear (about 42° C.), to immerse not only the affected joint, but a good part of the extremity above it, and to use enough water, sand or mud, as the case may be, to keep the temperature from falling too much during the bath, which ought to last about half an hour. I have never used any additions to mud baths. If one wishes to add anything to a water bath, ordinary sea-salt or cooking salt is just as good as the varieties of lye or the " spring salts," which are generally expensive, and the use of which is of advantage chiefly to the manufacturers ! (The massage séance should immediately follow the bath, which is taken once a day.)

The kind of baths just described have recently been partially replaced by *baths in rarefied air, hot air baths, light baths,* especially *electric light baths.* All these have very much the same effects as the others, but have an advantage in being more attractive and of more even temperature. Higher temperature is of no importance ; a local bath in dry air at 100° C. to 114° C. does not heat the tissues more than a local mud bath at 42° C. ; should the tissues be raised to a higher temperature than this (42° C.) certain proteids would coagulate and severe disturbances would result. It is not really known whether the electric light baths, beyond the effect due to their heat, have any effect deeper than the skin due to their wealth of ultra-violet " chemical " rays. *Local baths in rarefied air* were introduced by Junod in 1834, were in fashion for a short time, and have lately been taken up again by Bier. He encases the affected limb in appliances of various shapes, generally consisting of a firm glass case, open at one end or at both ends, which is connected with an air pump. This treatment is applied twice a day for ten to thirty minutes. India-rubber cuffs and bandages are used to keep the case air-tight, and it depends on the way in which these are applied whether the consequent hyperæmia is passive or active. If the bandages are applied comparatively loosely and the air rarefied comparatively little, an arterial hyperæmia results. If the bandages are applied tightly and much air is pumped out, a passive hyperæmia results, both because the bandages press heavily and because the atmospheric pressure forces the indiarubber cuffs firmly on to the skin.

For hot air baths, which produce arterial hyperæmia, Tallerman's and Bier's appliances are the most suitable. Various modifications of the latter kind are to be had at the present time. They consist of boxes of various substances in which the air can be heated by means of gas or spirit or (in Lindemann's apparatus) by electricity. These enclose the affected joint and at the same time are air-tight. They are used like the former in the treatment of practically every kind of chronic disease of joints, traumatic, rheumatic, or bacterial, and powerfully promote absorption (through the hyperæmia which they cause) relieve pain, and restore mobility. Treatment is given for an hour daily. The tempera-

ture of the air in such an apparatus may be 100° C., or at the highest 114° C.*

To Kellog we owe the construction of an electric light bath for local treatment.

Electromotor *air douches* are also used (Frey, Taylor, and others). Hot air is used in neuralgic and spastic conditions. But there are arrangements with two systems of pipes, one for very hot and one for cold air (to about — 10° C.). Such arrangements, which provide hot and cold currents of air alternately, are used to hasten absorption after joint affections with exudation.

The *Scotch douche* of hot and cold water alternately is even more valuable than the above in its effects, for a strong movable pressure, which can be called water massage, is here combined with the thermic effects.

But the most important hyperæmic treatment is most decidedly that recently recommended by Professor Bier of *treating by means of slight, but only slight, stasis, produced by an elastic bandage applied centrally to the diseased part.*

Passive hyperæmia so produced is a very general mode of treatment, not only of diseases of joints, but also of other affections, especially those of bones. Soft indiarubber tubing is used for the hip and shoulder, centrally to the joints; for more distal joints Martin's or some other indiarubber bandage is used. The bandage (or tubing) is applied rather firmly, so that the superficial and to some extent the deep veins are compressed, and so that a distinct hyperæmia with increase of volume is produced. It should not, however, be applied so firmly as to produce hæmorrhage (small red spots), pain, or any noticeable lowering of temperature; on the contrary, the static part should feel warm to the touch, and the patient should find the bandage comfortable. Professor Bier at first used this bandage for the greater part of the twenty-four hours (even for twenty-three hours), but now he more often uses it for eleven to thirteen hours, later on for eight, and finally only for one hour in the twenty-four. The treatment may, of course, go on for weeks and months.

It is well known that active hyperæmia promotes nutrition, healing and repair, as well as resolution and absorption.

Passive hyperæmia, on the contrary, has never been very highly thought of, and certainly has never been thought to assist nutrition and absorption. But these effects depend entirely on its degree, and I for my part, after only short but convincing experience, feel certain that *slight* passive hyperæmia may be of very great therapeutic value.†

There can be no doubt that passive hyperæmia under certain conditions improves the general state of nutrition. It has long been known that it promotes the growth of hair, and, what is of greater importance, it has been observed that it can promote the development of bone during

* Bier considers hyperæmia treatment to be of importance for medico-mechanical institutions, the work of which, apart from this, he, "bei aller Anerkennung der Erfolge," considers to be "ein entschiedene übertriebene Modesache."

We must not be too hard on this doubting Thomas!

† I refer my readers to Professor Bier's treatise "Hyperæmie als Heilmittel": Leipzig, 1903. It is possible that the book contains exaggerations, but it is certainly one of the most valuable medical works written during recent years.

puberty. When, a short time ago, I expressed my astonishment at the therapeutic value of passive hyperæmia to my friend Dr. P. Haglund he told me of a case of his in which a gangrenous process caused by an ulcer of the leg, in consequence of which amputation had been suggested, suddenly changed its character and began to heal immediately after a thrombus was formed in the femoral vein; at the same time the whole leg became swollen, active granulation began, a considerable sequestrum was taken from the tibia, and healing was completed with astonishing rapidity.

There is every reason to believe that passive hyperæmia has considerable antiseptic properties; in fact in this respect it seems more effective than active hyperæmia. It has long been known that anæmia favours the development of phthisis, that living up in mountainous country, with the consequent hyperæmia (certainly active), counteracts the disease, and that it is also counteracted by conditions causing passive hyperæmia in the lungs. If this depends on the fact that during the stasis the white corpuscles have, as it were, more time to eat up the tubercle bacilli, or whether it depends on the antiseptic properties of the increased carbonic acid, must be left undecided for the present. From Professor Bier's undeniably valuable treatise, even though he may exaggerate somewhat, it is probable that his static treatment of joint affections has its greatest value in the treatment of tuberculosis of joints, in which cases it would be a mistake not to make use of it. In hyperplastic affections of joints after metastases and in synovitis crepitans it is of value because, in addition to its other effects, it lessens pain most remarkably. I do not yet know whether it can also produce any considerable improvement in arthritis deformans.

Warmth in the form of flannel bandages is often applied in various joint affections, *e.g.*, in hyperplasia after metastases of the joint and in hydrarthrosis. They have their value, but it is not great, and for my part I gradually abandoned their use after my first few years of practice.

The *constricting, preferably elastic, bandages* with which forced compression is exercised in hydrarthrosis and hygroma have a quite different object from those previously mentioned. They are used with or without tapping of the joint, most commonly the knee, to promote absorption. They should be made of rubber, and should never be used unless the vessels are protected by a padded groove. I regard this as a poor and rather brutal mode of treatment.

There are still various kinds of *injections* to be considered.

Intra-articular injection, which is now considered somewhat antiquated, is used in obstinate cases of hydrarthrosis, generally with tincture of iodine diluted with an equal or double quantity of distilled water, in order to check serous effusion. After a few minutes the excess of fluid is allowed to run out, the wound is covered with a cross of adhesive plaster, and the patient is kept in bed until the acute synovitis which follows is over. Absorption often takes place without, though probably with greater certainty with, massage.

The more uncommon *parenchymatous injections* are performed in the following way. Two or three Pravat syringes filled with a 2 per cent. solution of carbolic acid are daily injected into the capsule itself, or into its immediate neighbourhood, in order to promote absorption during

chronic, or after recent, inflammation. Schüller has seen good results from this treatment, especially in cases of shrinking of the capsule and contraction after simple joint inflammations. If this treatment is employed at the same time as massage treatment, which, as far as I know, has never happened, it should be so arranged that injections are made for a few days and massage given for the next few days (proper attention being paid to the wound), and so on alternately as long as is necessary.

The *method of aspiration*, which should *always* be followed by syringing, is chiefly distinguished from injection in that it aims at removing the fluid which is mixed with pathological elements. It is a method which is very commonly used in treating excessive serous, bloody, or sero-purulent effusions in the joint, which threaten to overstretch the capsule and ligaments.

Aspiration with syringing can be used with advantage in so-called metastatic diseases of joints in which the exudation is sero-purulent. [In wholly purulent cases it is better to open by incision and to drain the joint.] For the puncture a fine or medium trocar is used, and for syringing a fairly large syringe, or an aspirator, with a solution of borax, salicylate or thymol (1 : 100), carbolic acid (2 : 100), or sublimate (1 : 5,000), after which a moderately tight antiseptic bandage is applied. Massage may be given later on as soon as the wound is healed, even if some exudation (non-purulent) is still present in the joint. By using this method one can often prevent the consequences of too prolonged distension of the joint, prevent permanent stretching, check serous effusion, and promote absorption; in certain cases this method may promote the healing of intra-articular fractures (see Patella Fracture). It is obvious that aspiration, like every other operation on a joint, must be carried out under strictly antiseptic conditions.

The latest method of treating joints is by *fibrolysin* and *injections of fibrolysin*. One makes injections of fibrolysin [= thiosinamin] between the gluteal muscles (rather than in the veins), generally making use of Merck-Mendel's ampullæ, giving a daily dose of 2·3 c.c., and about thirty injections in all. The effects of the preparation, which is essentially a urinary product, are thought to be due to its "lymphogenic, hyperæmic, and chæmotactic" properties. It cannot be denied that its effects in promoting absorption are most striking. This method has been used in gouty, chronic rheumatic, deforming, and bacterial diseases of joints, especially also in Hoffa's chronic progressive polyarthritis. It has also come into use in other chronic inflammatory processes—for example, Dupuytren's contraction and urethral stricture.

My own experience of this method is at present limited, but what I have seen has been promising: especially in one case of synovitis crepitans, in a strong-willed lady of seventy, when I had succeeded by massage in restoring almost normal mobility after it had been much reduced for a long time; walking, which was still rather troublesome, was greatly improved by further treatment, consisting merely of injections of fibrolysin.

Plaster of Paris is constantly being used in the treatment of affections of joints and ligaments. I merely remind my readers of the above-mentioned method of stretching shortened muscles by fixing the affected joint in its extreme position in plaster of Paris, which is renewed when the

shortened muscles have had time to be stretched by their own tonus, of Sayre's jacket in the treatment of scoliosis, of the value of fixation in plaster of Paris in assuring a normal position after fracture, of the necessity, for this reason, *e.g.*, with fracture of the fibula, of making the patient continue to wear this plaster when he is once able to use his foot. In all these cases plaster of Paris is of great importance, and its proper application requires a certain amount of skill.

Lastly, I must mention the "*portable apparatus*," often used both for the upper and lower extremities, which have this in common, that they consist of two metal splints placed along the extremity, which are held in position by leather straps and are jointed at the required places. These appliances, which in many respects differ widely, serve various purposes. Their use makes it possible to keep the weight of the body from the joints of the lower extremity (which is often necessary with children after tubercular arthritis), when the splints must, of course, extend from under the feet (where they are fastened to a laced boot) to the pelvis, which they support by means of various contrivances. In other cases an apparatus of this sort may be used to limit movements, *e.g.*, in *flail joints*, after inflammation, or after certain fractures (see Patella Fracture). It is then provided with simple mechanical arrangements suitable to the case. One can also, with the help of these appliances, stretch shortened muscles and other soft parts, either by screw power or by elastic power. In the latter case it is best to use solid rubber tubing in varying numbers of layers, more or less tightly applied, which is placed between hooks at suitable places for the purpose of attachment. [A solid rubber tube of this sort which has done good service happens to be in front of me now, and measures 6 mm. in diameter.] The same varied contrivances applied to the lower extremity, and provided with the necessary levers, enable the patient to give himself passive movements at the foot and knee with the help of a pair of ropes. Lastly, they are used when one wishes to compensate for paralysed muscles or muscle groups and improve mobility by so-called artificial muscles (*i.e.*, by means of the elastic tubing above mentioned). For example, when an extensor group is paralysed it is compensated for as far as possible by the constant action of an artificial muscle of this sort, which extends when the antagonistic flexors are not active and provides the necessary condition for their mechanical work. It is the duty of the doctor to see that the appliances fit the patient properly, and that, as far as possible, they do not hamper the circulation nor press on the muscles, and that the elastic, if any is present, is of the right strength. Even skilful instrument makers are apt to err in this respect for obvious reasons, the elastic generally being much too weak. The manufacture of orthopædic appliances has made enormous progress of late years, especially in Hessing's ambulatory splints, which fulfil the necessary requirements better than any earlier apparatus.

Scoliosis and Flat-Foot.

The following notes on scoliosis and flat-foot are really designed to give the masseur and medical gymnast an easily-acquired foundation for his knowledge of the subject. It would be advisable

for doctors to read carefully through Arvedson's, Haglund's, and Zander's contributions to this work.

Scoliosis is an extremely common complaint, most often occurring in girls from ten years old onwards. The commonest causes which contribute in varying degrees to the development of this deformity are anæmia and general weakness, especially weakness of the muscles, rickets, and a bad position at school. Infantile paralysis, pleural effusions, etc., are less common causes.

The examination of this condition is not particularly easy, and it is best for the patient to be undressed.

We first measure the distance on both sides between the anterior superior iliac spine and the tip of the external malleolus, or, in my opinion the best plan, between the anterior superior iliac spine and

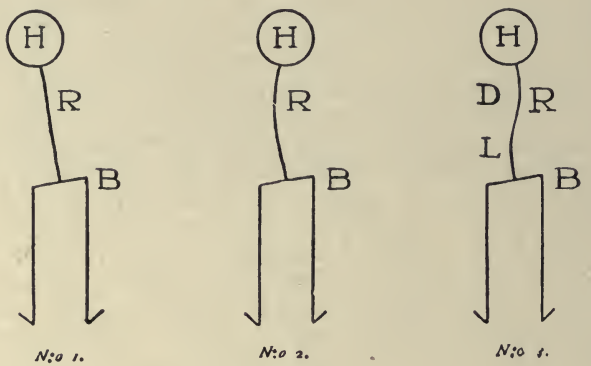

FIG. 182.

the floor, being very careful to see that the patient is in a correct position while this is being done.

In the majority of cases we then find that this distance is shorter on the left than on the right side, so that the transverse (frontal) axis of the pelvis is therefore also oblique.

We have thus a static cause for the development of scoliosis according to the diagrams above (Fig. 182). (The skeleton is viewed from behind.)

No. 1 shows that *R* (the spine) would take an oblique direction and the head be held to one side if the angles at the oblique (transverse) axis of the pelvis, *B*, remained at right angles and if *R* remained unbent.

No. 2 shows how the C-shaped scoliosis arises from position No. 1 owing to the patient's effort to bring the centre of gravity of the trunk over the centre of the supporting surface.

No. 3 shows the double S-formed scoliosis, with a compensatory dorsal curve *D* and a primary lumbar curve *L*, which arises from

the C curve as a result of these efforts and in accordance with anatomical, physical, and physiological conditions.

Of the two forms of scoliosis the C curve, which is often a transition stage, is less common than the double S curve, and the convexity in most cases is to the left.

The double S curve is the most common form of scoliosis, and the convexity in the lumbar region is usually to the left, that in the dorsal region to the right.

It is best to accustom oneself to denoting an S curve by first naming the primary lumbar curve according to the direction of its convexity (left or right), then the secondary dorsal curve; thus in most cases left lumbar and right dorsal scoliosis. At the present time there is some confusion in this respect.

A C curve is denoted according to the convexity as a left or right C curve.

The next step in the examination is to mark with pencil on the skin the positions of the spinous processes from the last cervical to the last lumbar vertebra; then to mark the position of the middle of the first sacral vertebra in the upper part of the hollow between the two iliac crests. While this is being done the patient stands with heels together in a slightly stooping position. When the marks have been made they are united by a line which makes the curves of the spine stand out clearly.

The patient then stoops as much as possible without bending the knees, and by standing in front and leaning over him one gets a good view of the whole surface of the back and of any changes present in the posterior part of the ribs.

It then remains to be ascertained, with or without special apparatus, how far the curves deviate from the middle line; how much the shoulder on the side of the dorsal convexity is raised in comparison with the other; to compare the broader convex with the narrower concave side of the back; to note the difference in the lateral contours of the trunk; whether the hip on the convex side of the upper curve protrudes; whether a possible shortening of one of the diagonals of the thorax or any kyphosis is present; and to observe, by comparing the lateral contours of the neck, whether the scoliosis also affects the cervical region.

To form a correct idea of the case it must be borne in mind that the bodies of the vertebræ deviate more from the vertical (to the same side) than do the spinous processes.

One next proceeds with the examination by letting the patient take the hanging fundamental position, or by putting him into the suspension apparatus. In very slight cases, which are called *scoliosis of the first degree* and which are the most frequent, the

patient's own weight is sufficient to make the lateral curve vanish and to give the spine its normal form for the time being.

In *scoliosis of the second degree* the pathological curves do not disappear entirely when the patient takes hanging position, but no very great changes in the form of the thorax are present.

In *scoliosis of the third degree*, the severest form, the thorax is seriously deformed, extremely immobile, the scoliosis very often combined to a serious extent with kyphosis, and there is always diagonal compression of the thorax in one direction. In these cases we find sharp curves, indicating wedge-shaped deformity of the vertebræ, and the ligaments on the concave side shortened, those on the convex side lengthened. The muscles have undergone similar changes, and are thin and atrophied on the convex, shortened on the concave, side.

The aim of the treatment is to make the spine (which is always stiffer than normal) more mobile, to put it into its normal position, and to fix it in this position. These various endeavours must go hand in hand with one another.

I wish to point out to my readers that it is not well for people with no medical training (masseur-gymnasts) to undertake the treatment of cases other than those of the first, or possibly slighter cases of the second degree. In all severe cases the treatment, consisting of a thorough combination of orthopædics, gymnastics and massage, should be entrusted to a doctor trained in mechano-therapy and with special experience of such cases, i.e., the director of an orthopædic institution. Treatment by spinal jackets should only be prescribed by highly trained specialists.

I have two further suggestions to make in all good-will to masseur-gymnasts without medical training with regard to their treatment of scoliosis, besides advising them only to undertake less severe cases :—

(1) *To treat these cases preferably by massage and symmetrical movements.*

(2) *Not to employ too many movements, but carefully to supervise those which are used.*

Asymmetrical movements involve more risk than symmetrical, but it ought to be possible to entrust even comparatively inexperienced gymnasts with a few such movements.

A masseur-gymnast can treat *slight* cases in the following way and be assured that he will do no harm, but only good, and may hope to prevent the further development of the scoliosis, or even to produce some lasting improvement.

This treatment consists of massage of the whole body, with special attention to the back muscles, or massage of the latter only.

The following positions and movements are used :—

1. Hanging Fundamental position.
2. Stretch-standing Heel-raising.
3. Wing-standing Trunk-bending-forward and -raising.
4. Wing-leg-forward-lying Holding.
5. Wing-arch-leg-forward-lying Holding.
6. Stretch-stride-sitting Double Arm-flexion and -extension.
7. Stretch-stride-stoop-sitting Trunk-raising with rod.

One may even restrict oneself to the use of Nos. 1, 2, 5, and 7. I have rather a weakness myself for No. 5 and No. 7, which involve strong action of the back muscles. I refer my readers to Arvedson's chapter for the technique. In using No. 7 I generally recommend a rod ; the patient often performs the movement better if he holds a rod between his hands.

Of the asymmetrical movements I only recommend two for the use of inexperienced gymnasts, one for a C curve and the other for an S curve.

For C curves and all single curves in the lumbar region we use ordinary side-flexions and side-lying starting position. It is a mistake to use the standing position as a starting position in these cases. Flexion must be taken towards the side of the convexity, but if this is done in standing position the force of gravity saves the muscles on this side from much concentric work, but, on the other hand, the muscles on the concave side are forced to perform such work to regain the starting position. Thus the movement exercises the strong instead of the weak muscles, and in quite the opposite way to that in which they should be exercised. With all C curves, and generally speaking with all simple curves, especially simple curves in the lumbar region, we therefore use Zander's *side-lying*-side-flexion apparatus (L2) or Ling's side-arch-leg-*lying* Holding (see Arvedson's chapter, p. 280, Fig. 133). The patient lies, of course, on the side of the concavity, and, if necessary, may receive slight help from the gymnast during the movement or in holding the position.

The gymnast should restrict himself to the use of stretch-spring-sitting-Holding when treating S curves (see Arvedson's chapter, p. 184, Fig. 51). With the more common right dorsal left lumbar curve we use left-stretch-left-spring-sitting Holding ; with the less common left dorsal right lumbar curve we use right-stretch-right-spring-sitting Holding. Stretching the arm helps to correct the dorsal curve, stretching the leg to correct the lumbar curve.

Dr. Klapp's creeping exercises have been recently much used in Germany, but the results have been very differently, often very severely,

criticised. Many eminent German specialists consider that on the whole this treatment has done more harm than good.

For my own part I have never used this treatment, but partly from what I have read, partly on theoretical ground, I have a great distrust of it. Dr. Klapp devised the treatment with the object of making the spine more mobile, on the ground that four-footed animals have more mobile spines than human beings, and the treatment consists in creeping "on all fours" in different ways according to different curves. But I maintain that we human beings are not quadrupeds, and that it is just in this respect that there is such a difference between children and, for example, kittens. In kittens the spine is placed horizontally and is supported both by the fore and hind paws; in children the spine is placed vertically and is supported directly merely by a part of the pelvis, indirectly by the lower extremities. If kittens, with their peculiarly mobile spines, were all required to walk upright (an amusing flight of imagination!), they would *all* become very scoliotic, whereas now a scoliotic kitten is, if zoologists will excuse the expression, a *rarissima avis!* This domestic animal, charming and graceful as it is, would then develop the most grotesque deformities, and a universal scoliotic "katzenjammer" would form a considerable addition to the "groans of creation" and the trials of this world.

The diminished mobility in the spine of a scoliotic child prevents further development of the deformity. The creeping treatment is a crude one-sided mobilising treatment which may lead to the neglect of other treatment. Since this result has been made known in the German literature on the subject, I consider it legitimate to draw attention to the doubtful value of this importation.

Flat-Foot. Pes planus + valgo-planus. Weak Foot.

Flat-foot is, possibly with the exception of slight scoliosis, the most common deformity.

In most cases the deformity is due to the fact that the *weight of the body falls on the feet*, and it arises owing to a faulty relation between the ligaments and other articular parts which hold up the arch of the foot. It therefore arises as the result of corpulence or of work involving much standing or walking. Rickets also, with its lack of hardness in the bones, is thought to be of ætiological significance.

Fatigue and pain easily produced by standing or walking are the subjective symptoms. The pain is felt chiefly in the astragalo-calcaneo-navicular ligament, sometimes also in the os calcis and even at the external malleolus, when there is marked valgus position.

Simple flat-foot (*pes planus*) is often combined with a permanent position of eversion, and is then more correctly *pes valgo-planus.*

"An inflammatory contracture," distinct eversion with no

power of inversion, may arise through reflex muscle cramp if the foot has been overworked. This yields quickly to an injection of cocaine in the astragalo-navicular joint, slowly to rest. Such a condition may become permanent owing to the contraction of the soft tissues if not treated.

The symptoms of flat-foot may arise owing to strain on the ligaments *before* the arch has had time to flatten out or even to sink. It is this condition which many modern orthopædists call weak foot. It is treated in the same way as flat-foot (except for surgical treatment in severe cases of pes planus or valgo-planus).

We find infiltrations along the inner part of the arch, and part of our treatment consists of massage of this region.

But massage alone can never effect a cure. It is of the first importance to correct the abnormal position of eversion and to support the arch of the foot. This is done by putting suitably-formed cork or metal soles into the patient's shoes, or, best of all, by using the so-called "Lange's valgus pads." Slanting heels (higher on the inner than on the outer side) are more rarely used. Gymnastic exercises to produce inversion are best performed by making the patient walk on tiptoe with the feet directed straight-forward.

CHAPTER XIII.

MUSCLES, TENDONS, TENDON SHEATHS, FASCIA AND BURSÆ.

Massage and gymnastics have an important influence in counteracting the atrophy of muscles caused by orthopædic treatment, or any other treatment necessitating the use of bandages. They are therefore often used either along with or after orthopædic treatment or fixation.

In atrophy or any kind of muscular degeneration massage therefore plays an important part, as in cases of atrophy from disuse, in paralysis of cerebral, spinal, or peripheral origin (e.g., poliomyelitis), in contractures, after fracture, after severe infectious diseases (e.g., typhoid), in chlorosis, diabetes, alcoholism, chronic lead poisoning, pseudo-hypertrophic muscular paralysis, etc.

In all these cases effleurage, pétrissage, and tapôtement are the most important manipulations, and these after a little practice can in many cases be given by any one. The treatment is of long duration, and requires only mechanical facility.

Myositis is a very common affection. The masseur divides most muscle inflammations into two pathological classes—*traumatic* and *rheumatic*. The cause of traumatic inflammation he discovers by the history and by palpation; muscle inflammations of which he cannot discover the cause he considers rheumatic. Muscle inflammation certainly results in many cases from changes of temperature, and is found especially in those parts of the body which are exposed, in the muscles of the head and neck, especially in the upper part of trapezius, occipitalis, sterno-cleido-mastoid, the scaleni, the pectoral muscles, the glutei, and the muscles of the forearm. But when these so-called "rheumatic" processes have an entirely different cause they may arise in any muscle, even those which are most protected from rheumatic influences. It has been thought possible, with thin abdominal walls, to palpate and remove by massage such myositis in psoas magnus (I. Lundberg. Upsala. Läkarför. Förh., 1887).

The examination of muscle inflammation, especially of the non-traumatic type, by means of palpation is one of the most frequent and most difficult tasks of the masseur. It necessitates first of all an accurate knowledge of the *normal* construction and consistency of each separate muscle, and when once this knowledge

has been acquired it is easier by means of palpation to discover slight objective changes, the symptoms of which are often troublesome. In many cases examination by palpation is very difficult, for the region which gives pain on pressure may be quite small, and the situation and extent of the infiltration can only be guessed. Even the most experienced masseur in forming his diagnosis must not disregard the information given by *tenderness on pressure.* The best method of examination is, after kneading the skin well with a lubricant, to give moderate pressure with the three middle fingers over the *relaxed* muscles ; the pressure must be adapted to the thickness of the tissues covering the muscles, and is given not only in the same direction as the muscle fibres, but also at right angles to them. By such examination of muscle, when the anatomical position is favourable, a complete knowledge of the condition of the muscular tissues is obtained by lifting the affected part between the fingers and carefully kneading it in the manner described for pétrissage.

The *acute myositis of non-traumatic origin* arises, like the chronic, generally in *portions* of a muscle, and may be found in scattered spots in one or more muscles. The corresponding parts are hyperæmic, swollen, and laden with serum, and exudation of the various elements of the blood occurs in varying proportions. *Palpation gives the impression of swelling of a doughy consistency and of lessened elasticity ; tenderness on pressure is often marked. Functional changes are often definite, and the patient avoids either contracting or stretching the painful muscles ;* hence arise positions of contracture.

If the inflammatory proeess is allowed to continue unchecked, the acute rheumatic myositis, with its fresh infiltration, is followed by a *chronic rheumatic myositis* with an organised infiltration of fibrous tissue, in which small acute processes occasionally appear. In such foci, which are often extensive, and may, for example, spread over one or both sides of the upper portion of trapezius, we find a great increase of fibrous tissue at the cost of the muscle substance, an "*interstitial fibromyositis,*" which in severe cases gives rise to creaking, as described by Frorieps as long ago as 1834. *The soft, doughy substance of the acute condition is transformed to hardened tissue, firmer than the surrounding relaxed muscle substance. In chronic rheumatic myositis the symptoms are less severe than in the acute ; spontaneous pain, tenderness on pressure, and loss of movement are less marked in this condition, and positions of contracture arise less often in chronic myositis than in the acute form.*

The symptoms of myositis vary considerably, according to the intensity of the inflammation and its position ; they are due either

to pressure of the inflamed muscle substance on the nerves or to neuritis caused by the spread of the inflammatory process by contiguity to the connective tissue of the nerves, and are of the nature either of reflex irritation or overflow of motor or sensory impulses; the physician often finds it difficult to diagnose with certainty. It is very important in nerve pains of doubtful origin in any region whatever to examine for myositis. *Thus myositis in complexus and trapezius often gives rise to occipital neuralgia; myositis in the various muscles of the neck often causes pain in the region of the cervico-brachial or cervico-occipital nerves; myositis in supinator longus causes pain in the region of the radial nerve (musculo-spiral). The same condition in the glutei and pyriformis and muscles of the thigh in the neighbourhood of the great sciatic nerves is not infrequently the cause of sciatica, etc.*

The pains, both when the disease is localised to one muscle and when it is in the course of a nerve, are very variable in nature, sometimes violent and acute, as in the case of *lumbago* due to myositis in the lumbar region (often in sacro-lumbalis), sometimes an indefinite dull ache, closely resembling feelings of fatigue, or the pains in anæmia and chlorosis. Important changes which may have escaped the patient's attention are often found by palpation.

In some cases there are symptoms of diminished elasticity and loss of functional power. I may remind the reader of "*rheumatic torticollis*" due to myositis in the scaleni and sterno-cleido-mastoid on one side; *of the lame or abnormal walk when there is myositis in the leg muscles;* of the way in which the patient tries to avoid all movement of the lumbar region when he suffers from "*lumbago*"; of the impossibility of hard mechanical work with myositis in the arm muscles (this last example often causes changes which must be referred to under the complex symptoms of "*writer's cramp*").*

Myositis, especially the kind in question, of rheumatic origin, of which the cause is unknown, often leads to a mistaken diagnosis; it is frequently mistaken for other diseases, and other diseases are not seldom mistaken for myositis. Beginners are often led astray in palpation by infiltration in the skin and subcutaneous tissue, by normal conditions such as lobulation of the subcutaneous fatty tissues, by differences of consistency due to the underlying parts (*e.g.*, in omohyoid near the shoulder joint), or to the formation of the muscle itself. Swellings caused by myositis are seldom so

* Myositis and neuritis give rise to the symptoms of writer's cramp. But since in many of these cases, to which I shall refer later, there are no perceptible changes in the arms, they must be included in the group of functional neuroses, the pathology of which is unknown.

definitely separated from the surrounding tissues as new growths of any kind whatever; nevertheless, I have seen new formation, especially gummata, mistaken for myositis by well-known physicians.

The pain caused by myositis is often of very variable nature; sometimes it resembles closely the pain of "pure" neuralgia and other neuroses; often it is similar to the pain present in chlorosis, anæmia, gout, poisoning (especially lead poisoning), or trichinosis, and other diseases caused by local processes. How often is pleurisy mistaken for intercostal "rheumatism"; and how often, again, is myositis of the pectoral muscles diagnosed as pleurisy! We can very easily be led astray by the symptom of pain on pressure. Remarkable mistakes may arise in this way; for example, I have known appendicitis to be mistaken for myositis when there has been pain in the anterior abdominal wall, for it is not easy to diagnose this from processes in the abdominal cavity. I also remember examining a patient who suffered from infiltration in the upper portion of the rectus abdominis, and until I had completed the examination I naturally suspected ulcer of the stomach. One must not impute to myositis all the symptoms which were formerly ascribed to it, nor must one accept without criticism too many new views which arise in this as in all other diseases. Rheumatic torticollis, according to Lancereaux, is caused by neuralgia in the cervical plexus; Robin and Londe give as its cause inflammation in the ligaments and articulations of the cervical region; Erbin also is of the same opinion. Nowadays there is a fairly general opinion that "rheumatic" torticollis does not exist. Both Robin and Erbin believe lumbago to be other than myositic in origin, and they suggest that it is in many cases caused by disease of the ligaments and joints, or it may be entirely neuralgic. I do not wish to enter into details as to the frequency of muscular and articular forms of lumbago, but I affirm that both rheumatic and traumatic myositis (over-strain of muscle) may give rise to it. One must bear in mind that syphilitic muscular affections must not be mistaken for rheumatic. Syphilis is found in the muscles in two different forms, either as diffuse muscle inflammation or as gummata. The syphilitic diffuse myositis (which most frequently occurs in the muscles of the calf and upper arms) can only be distinguished from rheumatic myositis by the result of treatment, in that the former does not yield to massage as does the latter. Gummata in muscle are more circumscribed and the swelling is more definite than that of rheumatic myositis, and more resembles the consistency of the traumatic form. Mistakes often occur, however, in cases of rheumatic myositis. Another problem which

often occurs in medical practice is to distinguish the false angina (pseudo-angina) pectoris from the true, which depends upon changes in the coronary arteries and cardiac muscles. "Nervous" people often complain of attacks of sudden acute pain in the region of the heart; the attack may occur either by night or day, the patient suffers extreme agony, and the attack can only be distinguished from the real angina when by examination it is found that there are no morbid changes in the heart and blood vessels, and it may be years before such changes do occur. On examining these cases one often finds myositis in the pectoral or other muscles of the chest, and one has a right to assume a causal connection between these two conditions, since the attacks often cease when the myositis is cured by treatment.

In connection with these phenomena I will mention briefly one or two conditions which, though not fully understood, are of special interest to the physician-masseur. Brissaud in his study of *metameric zones* teaches that the body, from an anatomical, physiological, and pathological point of view, is divided into certain zones or segments, each of which has its own nerve centre in the spinal cord and in the corresponding spinal ganglion, from which centre, by means of reflexes from the segments or metameric visceral parts, a neuro-trophic influence can be carried to the peripheral parts. Head, who has further enlarged this theory, believes that every internal visceral complaint produces certain external inflammatory and other reflex effects, especially hyperæsthesia of the skin, and, according to James Mackenzie, causes hyperalgesia in the subcutaneous tissue and in the muscles of the corresponding segment. It is to be hoped that in the future we shall more thoroughly understand many subjects which are not yet clear; we shall thus gain knowledge of the connection between peripheral and visceral conditions; for example, we shall discover the origin of subcutaneous and muscular infiltration, of the mysterious forms of local œdema, etc., which we now find puzzling. I pass on to mention a remarkable and interesting theory of the French-Swedish medical gymnast, Dr. Gustaf Krikortz.* He has drawn several conclusions from Brissaud's theory of metamerism, and holds that many, perhaps most, of the palpable changes in the skin and subcutaneous tissue and muscles are due to irritation of the corresponding metameric centres in the spinal cord produced by visceral lesions. Krikortz believes that the condition known and recognised as myositis in trapezius may be connected with tubercle in the apex of the lung, that myositis of the pectoral muscles may result from organic heart disease (arterio-sclerosis in the aorta or in the coronary arteries, acute dilatation of the heart, etc.), that infiltration in rectus abdominis may be caused by gastric ulcer, that cellulitis in the abdominal wall may be caused by disease of the uterus or its adnexa. All these suggestions are at present only theories, but theories worth considering, and of special interest for the masseur.

* "Contribution à l'étude du rheumatisme musculaire," by Dr. Gustaf Krikortz, Thèse: Paris, 1900.

Traumatic myositis occurs generally in the extremities, the shoulder, or the gluteal region ; it is far less difficult to diagnose than the myositis of rheumatic origin, for the history often throws light on the subject, and *the results of palpation are much more definite in the former than in the latter.* Muscle contusion is often associated with *ecchymosis*, that is, small patches of hæmorrhage in the muscular tissue, which as soon as the blood is coagulated form a circumscribed hard, inelastic swelling. There are also larger or smaller *hæmatomata*, which quickly form sharply limited swellings of almost cartilaginous consistency. Such cases are rapidly improved by friction and effleurage. *Immediately after muscle contusion it is very important to begin the treatment at once and go on with it until it is completely cured. There are two reasons why this is necessary ; one is because otherwise the infiltration of blood becomes organised and soon forms hard fibrous sclerosis in the muscular substance, the other because muscle contusion causes surprisingly rapid and extensive atrophic changes.* Especially after the so-called shoulder contusions, it is very usual to find marked changes in outline due to atrophy of the deltoid. All myositis, traumatic and otherwise, is in its first stages easily, quickly, and with certainty cured by massage ; less recent cases require months of work, and the treatment of sclerosis and extensive atrophy of muscles is an almost hopeless task.

After excessive or strong muscle contraction, either *strain* or *partial* or *total rupture* occurs in the skeletal muscles, even under normal conditions. These traumatic changes may occur in any part of the muscle, in the tendinous origin of insertion or in the muscle parenchyma. (Violent over-exertion may break off a portion of bone with its muscular attachment.) The commonest ruptures are in quadriceps femoris, the calf muscles, biceps brachii, deltoid, rectus abdominis, and in the muscles of the spine, especially in the lumbar region (traumatic " lumbago ").

The diagnosis is easy, partly from the history, which shows that the patient has felt a sudden smarting pain after or during a strong muscular strain, partly by palpation, which in the case of strain (partial rupture) shows an inelastic tender spot, and in total rupture a swelling more or less filled with blood. After this has healed, the swelling being replaced by new muscular and fibrous tissue, loss of function may persist, and the patient has the sensation of a foreign body being present, and from time to time has spontaneous pains. The sooner the case comes under treatment the more rapid and complete is the effect of effleurage and friction.

Teno-synovitis crepitans, with the usual serous or sero-fibrinous exudation into the sheath, is now mostly treated by massage,

which has quite taken the place of tincture of iodine or mercurial ointment. By the use of effleurage and friction the most important symptoms disappear at the end of a few days or a fortnight; if it is thought better to use other means at the same time, it is only necessary to apply cold compresses, leaving them on till they become warm. Bier and others use hot air and hyperæmia.

In clinics frequented by manual workers one unfortunately sees many cases of *purulent teno-synovitis*. When healing has taken place it is a lengthy and often thankless task to endeavour by means of strong frictions and passive movements to get rid of contractures, which frequently interfere with the patient's work.

Exudation into the tendon sheaths can also be treated by massage, but it is important not to rely too much on exclusive manual treatment, even in non-tubercular cases, especially when multiple. Fluid is often known to resist all treatment by massage. When the condition is obviously of a tubercular nature it is treated by puncture and injection, by hyperæmia, by excision, and by general anti-tubercular treatment.

Chronic inflammation of the fascia is without doubt much commoner than is believed, and often complicates myositis; and, in common with subcutaneous infiltrations of the connective tissue, is often mistaken for myositis or else overlooked. It is seldom on its own account treated by massage, which doubtless may be of considerable use in recent cases in removing the inflammatory products and curing the inflammation of the fascia, thereby preventing shrinking. In the preceding chapter, in speaking of Dupuytren's contracture, I referred to the amount of work required and to the difficulty of obtaining a satisfactory result.

Chronic bursitis, commonest in the prepatellar bursa (housemaid's knee) and in the olecranon bursa, with dilatation of the bursa, thickening of its walls, and increase of the contents (serous, colloid, or often hæmorrhagic), is often treated in Sweden with more or less success by friction and effleurage only. Injection of dilute tincture of iodine (1 : 3) appears to be a better and more certain method of treatment, causing shrinking or obliteration of the sac.

Tubercular bursitis is treated in the same way as tubercular exudation into the tendon sheaths (see above).

Gonorrhœal bursitis, generally serous (and usually in the bursa Achillis), may, when the acute inflammation has subsided, be treated by massage in conjunction with treatment by Bier's bandage.

In *acute purulent bursitis* the bursa is opened and healing is promoted by Bier's treatment. *Afterwards* friction may be used for its absorptive effect.

CHAPTER XIV.

SKIN AND SUBCUTANEOUS TISSUE.

Massage is of value in some skin affections. There are, however, contra-indications. For deep effleurage in particular the skin must be in tolerably good condition, and this manipulation is impossible in the case of certain injuries and diseases of the skin, where it might be easily broken. In the milder lesions, when massage may be given, one must remember that it increases the danger of infection of various kinds, and it is well, therefore, as a prophylactic to use an antiseptic. In the case of toxic foci in the skin, especially poisonous bites, if massage is employed, it must be preceded by thorough local treatment to avoid spreading the infection.

In *œdema* of the skin and subcutaneous tissue the value of massage depends entirely on the pathological character of the œdema. If the œdema is due to disease of the heart, kidneys or liver, or any other constantly acting cause, one can render the patient no real service by massaging the affected parts, as is often done by medical gymnasts. In this case, however, one may be justified by the prospect of a temporary improvement. But there is no justification for the indiscriminating enthusiast in massage who wants to massage away, not only the subperiosteal cephalo-hæmatoma, but also the caput succedaneum of the newly-born, which is for the most part serous, since both these conditions disappear without treatment. In the case of large cephalo-hæmatomata puncture with antiseptic precautions is much to be preferred to massage. On the other hand, as already mentioned, massage has a real value in getting rid of œdema after constriction. It may also be used after thrombosis for this purpose and to hasten the development of the collateral circulation, but should only be begun after organisation of the thrombus, in my opinion not less than three months after its formation.

Infiltrations, *ecchymoses*, and *hæmatomata* after injuries, especially bruises, are common in the skin and subcutaneous tissue, as they are in the muscles, and are got rid of by effleurage and friction more easily and surely than by any other means.

The changes in the skin and subcutaneous tissue arising during

chronic, or remaining after acute, inflammation should especially be treated by massage.

We have first to consider the infiltrations of rheumatic and traumatic origin in the true skin (Natvig and Gade) and in the cellular subcutaneous tissues. The common infiltrations found in the back of the neck and other parts of the head and neck undoubtedly belong to the former class. They invade the skin and subcutaneous tissue as well as the muscles and nerves, and are generally treated along with myositis and neuritis.

Subcutaneous infiltrations are found in the abdominal wall in women much oftener than in men. They are thought by some to be connected with the wearing of corsets, but according to others are a reflex result of pelvic or abdominal lesions. They are often very tender to pressure. They are distinguished from myositis by their more superficial position and by the functional power of the muscles being normal. On palpation they give the impression of a more "fine-grained" formation than the normal fatty subcutaneous tissue. These subcutaneous infiltrations, which are often called *cellulitis*, may give rise to the same mistakes in diagnosis which I considered in connection with myositis in the abdominal muscles. Since they give rise to severe subjective symptoms, they frequently come under treatment by massage, but are often slow in yielding to treatment.

Purulent processes in the skin and subcutaneous tissue, as elsewhere, contra-indicate all massage. It would not occur to any intelligent or competent person to treat acne, boils, carbuncles, or erysipelas by massage. But the hardenings and thickenings remaining *after* such affections may be got rid of by friction and effleurage.

After erysipelas in particular this treatment may be given with great benefit, as Professor Gussenbauer has so well demonstrated. His patient was a man of seventy-two, who, after repeated attacks of erysipelas, presented an elephantiasis-like swelling of the forearm, with the skin thickened, red, and covered here and there by papillary excrescences, with wrist and elbow stiff, and great aching of the arm when hanging down. The condition was such that amputation was justifiably considered. The arm was suspended vertically for four days and nights under injections of morphia: adhesions in the tendon sheaths were freed by passive movements; massage and compresses did the rest, and in three weeks the patient was permanently freed from the aching, swelling, and stiffness of the joints.

I have already mentioned that during *scar formation* massage has the power of keeping it within certain limits. When the *scar* is complete, at its best and freest, and still quite recent, strong fric-

tion performed over the whole area with quite small movements of the finger-tips (not to break the skin) can produce atrophy of the scar tissue and make it much thinner. This chiefly comes under consideration if the skin over a large area has been injured by a *burn* of the third degree, *i.e.*, with destruction of the true skin, when friction is a useful adjunct to gymnastic, orthopædic, or surgical treatment.

Ulcer of the leg is with great advantage treated by massage along with external medication. Friction is given especially over the edges of the ulcer, which are often much infiltrated and thickened, and even over its whole surface. Effleurage is given over the whole leg. In marked cases of varicose veins with phleboliths, which are generally found in the leg, stroking over the corresponding parts must be performed very cautiously; but even in these cases one can generally continue the stroke more strongly over the femoral vein in the thigh. An elastic stocking should also be used. Effleurage should be given at least twice, sometimes three or four times, a day. This often requires caution, but is nevertheless so simple that an intelligent servant can be trusted to do it. It sometimes happens that ulcers which for years have defied all forms of treatment heal within a few weeks under this method.

Some other skin affections may with advantage be treated by effleurage along with other treatment. Effleurage is given cautiously over the affected area, and centrally over the blood vessels leading from it. This is of course more particularly the case with regard to the extremities, and especially with regard to affections of the forearm and leg. *Chronic eczema* is often healed in this way. Unna has treated *lupus* successfully, and Murray *prurigo* by massage. Shoemaker, Rosenthal, and others recommend in *acne vulgaris* that the ordinary treatment of opening and disinfecting the pustules should be followed by effleurage.

Mezger has treated *teleangiectasis* of the skin by massage, pressing upon the afferent veins with the fingers of one hand, so that the small vessels become distended with blood, and then crushing them with the thumb of the other hand working from the periphery. When the teleangiectasis extends over the soft parts of the nose Mezger inserts an ivory rod into the nasal opening in order to have a hard surface for friction. After the treatment a hardness remains for some time in the skin and subcutaneous tissue, but no new formation of blood vessels takes place.

Massage in the form of effleurage, light friction, and tapôtement is of use, especially if used early in *sclerema or scleroderma*. The same holds good for *sclerema neonatorum* found in atrophic infants.

In the earlier editions of my book on massage I recommended a

definite form of massage treatment for *frost-bite*, which is common in Sweden. This treatment consists of effleurage over all four extremities, preferably combined with abdominal kneading for its effect on the blood-pressure and circulation, and has a much greater effect in limiting or averting threatened gangrene than aimless kneadings and vertical suspension of the extremities. I had such a case to treat in Neglinge in 1898. The patient was a workman who, being incapacitated by his daily alcohol and unable to reach his home, took his night's rest in a snow-drift, the temperature being — 22° C. My first decided impression was that the hands and feet were likely to become gangrenous. Meanwhile I ordered effleurage over all four extremities, given simultaneously by four people for two hours (to begin with in a cold room) and repeated several times a day. Abdominal kneading was given at once. The result of treatment was surprising in the extreme. The upper limbs and one leg completely recovered, and only a small part of the tip of the great toe of the other leg became gangrenous. Since then other cases of frost-bite in Sweden have been treated in the same way with excellent results.

Energetic and extensive effleurage has of course the same effect in preventing or limiting local death in cases of *gangrene*, but can generally only be performed centrally from the gangrenous skin area.

CHAPTER XV.

NOSE, PHARYNX, LARYNX, AND EARS.

MASSAGE of the nose, gullet, larynx, and ears has much in common in regard to technique and pathology. It is also performed by the same specialist, and may therefore be suitably considered together.

The commonest affections of these parts that are treated by massage are the chronic catarrhs. *Chronic pharyngitis* is often present alone, but frequently spreads to the tonsils as *chronic tonsillitis*, and sometimes also to the middle ear through the Eustachian tube; *chronic laryngitis* is often present alone, but is not seldom part of a catarrh affecting the whole naso-pharynx.

We must admit that the treatment of all these forms of catarrh and of their sequelæ, except in the case of polypi which are easily removed, has been on the whole very unsatisfactory. It seemed, therefore, a great therapeutic gain when massage was at last made use of in this department. The so-called massage of mucous membranes is generally performed by fine, quick vibrations. The Swedish gymnast A. Kellgren, of London, was the first to use or at least to introduce this method into general use. He performed the vibrations on the skin partly over the nerves (supratrochlear, nasal, superior and inferior laryngeal), partly over the angles of the hyoid bone or larynx, or over the neck below the angle of the jaw, etc. Even in this indirect and somewhat primitive and coarse form vibrations (preferably given with a vibrator) seem to have been beneficial, whether used alone or preceded and followed by effleurage of the front of the neck, as practised by Ling and revived by Gerst.

Vibration by means of instruments directly upon the affected mucous membrane was introduced by the Austrian Dr. M. Braun, and after him by Dr. C. Laker. I shall here consider this form only, since its technique is more fully developed and its therapeutic effect more certain.*

* The so-called mucous membrane massage has for long been used by gymnasts in Sweden; in Stockholm Captain Tersmeden has been working in this way since 1886. Like many other workers, he uses a sound or the tip of the forefinger in the throat and the tip of the little finger in the nose. Dr. M. Braun, of Trieste, wrote a paper in 1890 entitled "Massage, beziehungsweise Vibrationen der Schleimhaut der Nase, des Nasen-Rachen-Raumes und des Rachens," and Dr. Laker, of Graz, in 1892 published "Die Heilerfolge der inneren Schleimhautmassage bei der chronischen Erkrankungen der Nase, des Rachens, der Ohres und des Kehlkopfes." Professor Chiari, who also made use of massage in this

For the treatment of *chronic rhinitis* straight sounds without handles are used,* the end being wrapped round with a thin layer of cotton-wool, generally dipped in some effective local remedy. Kreolin is used, 5 to 10 per cent. solution of cocaine, 2 to 8 per cent. menthol-vaseline, etc. For *ozœna* Laker recommends iodine (1 per cent.) in iodide of potassium and glycerine.

Laker recommends that the treatment should be preceded by a thorough rhinoscopy, so that one is familiar with the varying normal and pathological local conditions in each special case. He then carries out the treatment without the aid of sight, standing on the right side of the patient, who is sitting; with the four fingers of his left hand he fixes the patient's head, which is leaning back, and with his thumb raises the tip of the nose. With his right hand pronated Laker holds the sound between the thumb and forefinger, and performs by means of the tonic contraction of his arm muscles and the accompanying rapid trembling of the hand small vibrations at the rate of 600 to 2,000 a minute on the corresponding part of the mucous membrane. In this way he works successively on the whole mucous membrane, on the septum and turbinates, etc. The sittings are from a shorter time up to several minutes, and especially in the beginning are painful to the patient and tiring for the doctor. Bleeding is often produced.

Laker values vibratory treatment both for simple, hypertrophic, and atrophic rhinitis. In the hypertrophic forms, according to Laker, the indications for galvanic cauterisation have been completely changed by the introduction of massage, and since then he only cauterises in extreme cases of hypertrophy and for polypi. After their removal massage is an excellent after-treatment, because it makes the affected region more healthy and prevents recurrence. Even in the atrophic forms he considers the treatment very effectual, for the mucous membrane soon becomes moist, the crusts are easily loosened without hæmorrhage, and finally cease to be formed because the secretion becomes looser and is gradually got rid of; the odour disappears. He allows that a long

region, and found it of moderate value, has criticised (perhaps rather strongly) Braun, Laker, Höffinger, and others in the *Wiener Klin. Wochenschr.*, 1892, Nos. 36, 40, and 42.

I would further refer to the introductory account of this treatment :—Lahmann's paper in *Allg. Medicin Central Zeitung*, 1892 ; Anton's paper in *Prager Med. Wochenschr.*, 1892 ; Daly's in *Med. Mirror* (November, 1892) ; Garnault's (" Le massage vibratoire et électrique des muqucuses du nez et du larynx ") in *Sém. Med.*, Août, 1892; Storck's (" om Slemhindemassage i Særdeleshed vid Behandlingen af ozœna ") in Förh. v. 14de. *Skand-Naturforskermïde*, i Köbenhavn, 1892 ; Laker's in *Deutsche Med. Wochenschrift* (No. 43), 1892 ; and in *Wiener Med. Presse*, Nos. 47 and 48, 1892, and Chiari's reply in this journal (No. 50), 1892 ; and, finally, Anton's paper in *Prag. Med. Wochenschr.*, No. 49, 1892.

* Laker's sounds are of copper or other material, 23 cm. long, of a thickness corresponding to No. 6 or 7 (Charrière's scale). The end of the sound varies in thickness and is rough for 1 cm., ending in a little button, so that the cotton covering, at all times rather thin, can be securely attached. The remaining 11 cm. are smooth, the handle again rough.

period of treatment is necessary; during this, loss of the sense of smell is often the most obstinate symptom, and he dare not promise its restoration to normal with the same certainty as the cure of other symptoms, although this often takes place quite suddenly. Purulent rhinitis is often quickly cured. In simple forms the swelling and secretion is diminished and nasal respiration quickly returns. In general five days elapse before any considerable improvement is seen; the usual pathological reflexes, especially due to changes in the anterior parts of the turbinates, vanish in a wonderful manner.*

Breitung connected the nasal sound with an electrical apparatus to give vibrations. Some specialists use an oval lenticular, rather thickly-covered rubber capsule, which is inserted into the nose and connected with an air pump after Delstanche's principle (see below); vibrations are given to the mucous membrane by the alternate dilatation and contraction in quick time of the capsule.

Personally I may say that results are more quickly obtained if vibrations can be given with the tip of the little finger rather than with any other vibrator.

Velpius has constructed an instrument by which stroking (forward and backward) may be applied to the turbinates.

Laker also uses cotton-covered sounds dipped in the above drugs in the treatment of chronic *pharyngitis;* the sounds for this purpose, when treatment is to be applied to the roof of the pharynx and the post-nasal region, are screwed to a handle similar to the ordinary handle of the laryngoscope, and have a terminal of 1 to 4 cm. long bent at right angles. He also works through the nares upon the naso-pharynx with the straight sound already mentioned. In treating the pharynx, however, one can work more effectively with the tip of the first or second finger by small, rather firm frictions than with a sound or vibrator. For the roof of the pharynx the bent sounds mentioned above are perhaps most suitable; examination must first be made by the mirror of the laryngoscope. In treating various forms of pharyngitis I have personally been accustomed to insert, by means of forceps, quite a large cotton pellet dipped in alum, and with this work energetically

* Laker uses, unfortunately, very much too strong expressions with regard to the therapeutic results in treating rhinitis especially: "Gerade von zauberhafter Wirkung ist das Verschwinden der pathologischen Reflexscheinungen: Kopfschmerz, Migrän, Stirndruck, Thränen, Husten, Neuralgien, üble Laune, Gedächtnisschwäche," etc.

These and similar expressions led to Professor Chiari's perhaps rather uncharitable criticism, and made me at first unjust to Dr. Laker in underrating the value of his otherwise serviceable contribution to mechano-therapy. From what I can ascertain, neither his own nor any other person's results are quite *so* brilliant. The fact remains that all the atrophic forms are very obstinate to treatment of any kind. With regard to the hypertrophic forms of rhinitis, massage is often only an adjunct to surgery, and out of twenty-seven cases with adenoid vegetations Laker himself operated in twenty-one cases.

upon the mucous membrane for as long as the patient can bear it, and continue these daily treatments, usually for several weeks, until considerable improvement has been obtained. I have not considered vibrations with smooth beautiful curves *à la* Laker of the slightest importance, but have only kneaded as I thought suitable with considerable strength. In severe cases of pharyngitis one obtains in this way good results comparatively quickly. I remember that I succeeded in one case of a Swedish artillery officer in astonishing the famous Austrian specialist Dr. Müller in Carlsbad, who was at the same time treating the patient for disease of the ear.

In the massage treatment of *diseases of the larynx* we give direct local vibrations and neck effleurage in chronic cases, the latter alone in acute cases.

Laker orders vibrations for *chronic laryngitis* and for "*weakness of the vocal cords*," which "absolutely disappears, leaving no trace behind where this is at all possible" (not, of course, where the cause is in the central nervous system, or due to pressure of an aneurysm on the recurrent laryngeal nerve, etc.); likewise he recommends vibrations for infiltrations and for *ulcers* of whatever character.

The technique resembles that described for rhinitis. The sounds employed for this are more delicate and similarly bent, and in shape they resemble the handle of the ordinary larynx brush; the end is bound with cotton as far as 4 cm. up, and Laker in these cases dips it into a 10 per cent. solution of cocaine. Under control by the laryngoscope the sound is inserted below the true vocal cords, while the glottis is open during inspiration. At the least touch the sphincter of the larynx contracts; the sound is firmly gripped by the larynx, and the vibrations may be begun first towards one area and then the other, but naturally can only be continued quite a short time. (The sinus pyriformis, the valecula, and all the various parts of the larynx only require one form of sound.) Too strong pressure easily produces ecchymosis. The reaction after treatment may be very strong, and often one is able to apply treatment only every third or fourth day.

Many doctors also use vibrations outside the larynx. Stangenberg in Stockholm makes use of the vibrator here also. Without wishing to express a definite opinion on the subject, he evidently assumes its probable usefulness.

With regard to the therapeutic results of massage by means of vibrations and frictions on the mucous membrane of the nose, pharynx and larynx, so very differently criticised by specialists, I now consider it certain that in comparison with what is obtained by other treatment the results may be said to be very good. With

simple catarrh it is easy to obtain good results; with the hypertrophic forms an energetic curative and prophylactic effect is obtained, and the indications for the use of the galvano-cautery treatment are diminished and the results of its use improved. In the atrophic forms, *i.e.*, in *ozæna* and *dry pharyngitis*, with their symptoms troublesome both for the patient himself and for those around him, one has a very hard, but at the same time not altogether thankless task. The treatment must often be continued for months and be repeated later.

By the therapeutic effect upon the mucous membrane of the pharynx a beneficial effect is also exercised upon catarrh which has spread to the Eustachian tubes and to the ear; by the same effect on the mucous membrane of the nose a similar influence is exercised upon catarrh which has spread through the lachrymal duct and possibly affected the lachrymal sac and conjunctiva.

Among the *acute* catarrhs of this region, *acute laryngitis* especially has been treated by Gerst, and later by others, by neck effleurage. In the case of *false croup* especially, good results may be expected from the treatment, which has won such high praise from Bela, Weiss, and others. It should in particular be directed energetically against *œdema of the glottis* due to this or other causes.

From the above experiences and those of other specialists we may say that, compared with the usual treatment, neck effleurage is of some value in assisting the healing of syphilitic, tubercular, croupous, and diphtheritic processes in the larynx.

* * * * *

During the last quarter of a century Urbanschitsch, Politzer, Lucæ, Delstanche, Hegener, and many others have introduced and upheld massage in the treatment of diseases of the ear.

Ear massage consists partly of "external ear massage" in the form of neck effleurage and other movable pressure on the external parts of the ear, partly of "internal ear massage" in the form of vibrations or frictions upon the drum or in the Eustachian tubes.* Massage of the pharynx and nose, for catarrh, is often associated with treatment of the ear, since catarrh of these parts is apt to spread to the tube or middle ear.

* As early as 1883 Eitelberg wrote a series of articles in the *Wiener Med. Presse* on massage in diseases of the ear, and in Bum's "Mechanotherapy" there is a long treatise as to the mechanical treatment of these diseases. The greater part of this treatment, however, cannot be said to be massage; neither the static pressure exercised by means of "tampons" or drainage tubes, nor the dilatation by means of a sponge or laminaria tent, or the insertion of a sound belong to massage. As I wish rather to show the reader what may help to give him a complete survey of the use he may make of massage and gymnastics in the various departments of his practice, and not to deal with every mechanical detail which may arise in the performance of this treatment, I have not thought it necessary to deal with other means than those which exert movable pressure by means of the hand or an instrument.

The most effectual part of *massage of the inner ear* is that which aims at applying vibrations through the external ear passage to the tympanic membrane and to the chain of small bones in the middle ear.

We have two different types of instrument :—

(1) Lucæ's vibrating sound, and

(2) Delstanche's pneumatic vibrator, the so-called " rarefier."

Both instruments have undergone various modifications, both by the inventors themselves and by others, during the years which have passed since they were first invented ; for full details I refer to the special works.* In Sweden instruments are most used which are constructed after Delstanche's pattern, and aim, by means of rapid alternate condensation and rarefaction of the air in the external auditory meatus, at administering vibrations to the tympanum.

Lucæ's first vibrating sound consisted of a hollow metal handle containing a spring and of a sound connected with it, ending in a little cup-shaped terminal and running in a tube. After having injected into the ear a 10 per cent. solution of cocaine and covered the sound with cotton-wool, the terminal is placed by means of a speculum on the tympanic membrane just above the short process of the malleus. At first vibrations are administered with the hand.

Nowadays vibrations are usually given with an electro-pneumatic apparatus. A glass cylinder may be inserted filled with lukewarm water. According to Lucæ this hydro-pneumatic apparatus is the most satisfactory and transmits to the sound a large number (2,000 to 4,000) vibrations a minute.

The first of Delstanche's apparatus for *pneumo-massage* of the ear, the so-called " rarefier," consists of a little syringe worked by hand, with a spring placed in front of the piston in a cylinder, which pushes the piston back as soon as the finger (thumb) ceases to push it forward. The syringe is combined with a small rubber tube. This may end *either* in an oval bored ear-plug which hermetically closes the external ear passage, *or* in a little terminal tube placed in the side of Siegle's speculum. In the last case one has the advantage of being able to regulate and notice the effect upon the tympanum *during* the air massage, as well as to examine the mobility of the drum and malleus. Lucæ also inserts here his glass tube filled with warm water between the tube closed by a thin elastic rubber membrane and the ear, and considers the *hydro-pneumatic massage* thereby produced more effectual. In order alternately to rarefy and condense the air in the external ear

* In particular to Louis Blau's " Bericht über die neueren Leistungen in der Ohrenheilkunde " : Leipzig, 1902.

passage by means of quick small vibrations definitely limited as to their excursions, a motor has been constructed for this apparatus, driven by electricity (Breitung, Noebel, Warnecke, Cordes, etc.). These are also to be had worked by hand or by a sewing machine.

Jankau has introduced what he calls "double massage" by carrying two tubes from an air pump (rubber bulb), one to the outer ear passage, the other to a catheter introduced into the Eustachian tube, by means of which the drum and chain of small bones can be treated by vibrations at the same time both from within and from without.

Other instruments and apparatus for the same purpose have also recently been constructed, which need not be further referred to here.

The Eustachian tubes are massaged by Ernst Urbanschitsch and others by means of a thin sound or bougie which is inserted through the catheter 3 cm. at the most, *i.e.*, not quite as far as the internal opening of the tube, and which is set in quick piston-like motion with small excursions either by the hand or by means of an electro-magnet. This is useful in *stenosis* and in *chronic catarrh of the tube*, and also to counteract subjective sensations of sound by stimulating the auditory nerve and so producing changes in it.

All these manipulations are used for chronic catarrh in the inner ear, for adhesions in the auditory chain of bones and in "sclerosis" in the middle ear, because in one way or another they set in motion the tympanum and small bones. It is attempted in this way, and to some extent successfully, to improve hearing and diminish the singing noise and other subjective symptoms in the ear. To influence catarrh in the ear it is of course necessary to treat the nose, throat, and Eustachian tubes.

The work of specialists in this department seems to me on the whole very useful, but far from complete.

One must be careful not to make too big vibrations (over 2 mm.) so as to produce injury to the tympanum, or to the articulations between the small bones, or between the stapes and fenestra ovalis. The treatment should not be painful. Contra-indications to such treatment consist of all *acute* inflammatory processes in the middle ear, of all conditions where there is normal hearing, and of atrophy, adhesions, and indrawing of the tympanum (Ostmann).

The internal ear massage described above may be assisted by *external* ear massage, which is also used alone for many external diseases of the ear.

It is also possible, as Politzer has done, to massage the tube by frictions immediately under the external ear between the mastoid process and the ascending ramus of the lower jaw.

In slight chronic catarrh of the middle ear Hommel orders the patients to give themselves vibratory treatment by means of the air in the external ear passage four to six times a day for a minute or two, by pressing the tragus against the external opening at the rate of 120 to 150 times a minute.

Reinhard and Ludwig, Zaufal and others use neck effleurage, with downward stroking from the mastoid region, in a similar manner to that performed by Ling and later by Gerst, for its beneficial effect upon absorption of *acute and chronic exudations in the middle ear.* The neck effleurage in these cases should include the region in front of the tragus, by means of which a considerable emptying of the veins takes place. Finally, one is able, as Dr. Stangenberg of Stockholm tells us, in such cases and in all chronic catarrh to use vibrations with advantage (with any vibrator) outside the ear in the mastoid fossa and all round the external ear. Under this treatment Stangenberg states that the usual noises in the ear are in many cases considerably diminished.

In *suppurative otitis media* during the acute stage the only suitable form of massage is neck effleurage, which is used for its antiphlogistic effect, and after the usual treatment and the removal of the pus to assist healing and prevent the disease becoming chronic. Even in this latter case, in Gerst's opinion, one may with advantage use neck effleurage several times daily for long periods.

Massage has been tried in cases of pure *neuroses of the ear.** Politzer (in his " Lehrbuch d. Ohrenheilkunde " : Stuttgart, 1887, p. 425) says : " In many cases when (in otalgia) pain attacks the whole region of the ear and specially increases with pressure on the region between the ramus of the lower jaw and the mastoid area, corresponding to the course of the cartilaginous part of the tube, I noticed, after repeated massage for several days, a considerable improvement, even a complete disappearance of the otalgia."

Stangenberg recommends vibrations given with a vibrator on the outside of the ear in these cases. In similar diseases one ought specially to massage over the auriculo-temporal nerve ; it is also useful to treat the supra- and infra-orbital nerves (Urbanschitsch).

Hæmatoma of the ear was treated with massage first by W. Meyer, then by Blake and Urbanschitsch.†

When hæmatoma of the ear arises in mentally healthy persons (or in those of the insane, *e.g.*, the demented, who are not excited

* I would call attention to the difficulty and necessity of making oneself sure of the diagnosis. One must particularly exclude disease of the teeth and ulceration in the throat, and examine for tenderness to pressure over the auriculo-temporal, great auricular, and small occipital nerves.

† W. Meyer, in " Arkiv. f. Ohrenheilk.," 1880 ; Blake, in " Zeitschr. f. Ohrenheilk.," B. xiii.

by the treatment) massage, to judge from the results of the above-mentioned doctors, seems to be equally indicated, as it promises quite as good results as bandage, compress, painting, or surgical treatment, and, possibly to a greater extent than these, may prevent further deformity of the ear.

Politzer, however, states that with small painless hæmatomata healing should be left to nature ; that painful blood tumours ought not to be treated with either bandages or massage, and that in other cases one ought only with the greatest care after three to four weeks to make use of the latter treatment, which otherwise may cause fresh hæmorrhage.*

Zaufal massaged away *thickening in the external ear after chronic eczema.*

Diffuse external otitis has been successfully treated by Gerst by neck effleurage for ten minutes three times daily.

Urbanschitsch orders massage (alternating with tampons) by means of strokings over the affected part for *circumscribed external otitis* (= boil in the external ear passage).

* "Lehrb. d. Ohrenheilk." : Stuttgart, 1887.

CHAPTER XVI.

THE EYE.

Ever since 1870 when massage was introduced by such an influential advocate as Donders it has been employed by eye-specialists; he used it, as Heiberg of Christiania did shortly after him, for corneal opacities. But it was Pagenstecher who did most for the introduction of massage into ophthalmic surgery (since 1878).* There is no doubt that massage is now and for the future of considerable importance as a part of ophthalmic treatment.

The technique of eye massage is exceedingly simple. In the majority of cases, whichever part of the eye one wishes to massage, mechanical treatment by means of kneading over or through the eyelid is used. As regards technique there are several not unimportant variations and different opinions thereon. In my opinion it is best to press the eyelid with the tip of the middle finger and massage with this. Pagenstecher, who has a right to be heard on all these subjects, in massage of the eyeball grasps the upper or lower eyelid near the edge between thumb and finger and performs gentle kneadings with this, always with the minimum of pressure. Pagenstecher distinguishes in this between radiating and circular kneadings, and considers the first to be the more important; they are performed from the centre of the cornea towards the equator of the eyeball. In circular massage, again, the kneadings are performed over the corneo-sclerotic margin. In radiating massage one can only work upon a sector of the front of the ball at a time, and can in this manner cover the whole area, if necessary, successively in four parts. During massage of the upper sector the patient must direct his gaze downwards; when later the outer sector is being done he must look inwards, etc., and in this treatment only the under sector is kneaded by means of the lower lid, all the other three sectors with the upper lid. In order to be certain which part of the ball one is to massage through and by means of the eyelid, a clip may be used to hold the patient's other

* "Nothing is new under the sun," and many statements are to be found on the use of eye massage in early ages, besides which it has for long been used in many places even by professional men of our time in the clinics, as, *e.g.*, in Bohemia (according to Schenkl) and in Italy (according to Gradenigo). Even the Swedish gymnasts have contributed to this (Nicolaysen), which is not surprising considering their great readiness in every case of disease to lend a helping hand, and considering the universality of diseases of the eyes.

eye open. The kneading takes place, as has been said, in rather quick time. Kiær tells us that he performs 120 to 150 kneadings a minute, *i.e.*, in radiating massage he performs this number of kneadings towards the centre of the cornea and back again, over the whole corneal margin in circular massage. Personally I have found that my own time is somewhat quicker and that I perform about 200 " strokes " a minute.*

For massage of the eyeball I always find it most comfortable to use the tip of the middle finger pressed gently against the eyelid, while I perform the movements necessary for the manipulation for the most part at the wrist joint, though the whole of the forearm also plays some part (see p. 27). This must, however, be Pagenstecher's method, as the diagrams showing his radiating massage in Reibmayer's " Technique of Massage " show the middle finger as the one performing the kneadings. It is best that each should use the finger which suits him best.

But one may make a few justifiable and helpful remarks concerning the pressure and form of the kneadings. The radiating kneadings follow more the direction of the vessels of the sclerotic and episclerotic coats, and they assist, therefore, the circulation in these vessels more than other kneadings and work more or less like effleurage. They are therefore chiefly useful in the (comparatively few) acute diseases of the eye which ought to be treated by massage, and must be performed most lightly so as to not to produce irritation. But the difference with regard to the effect on the local circulation between kneadings in different directions on the eyeball cannot be very great, when the tip of the finger covers at one time so large a part of the whole area over which its excursions are made. The aim of the manipulations in eye massage is, like that of friction, to promote absorption. It is therefore practically indifferent in which direction they are performed, and therefore, in company with other doctors who have far greater experience in eye massage than I myself, I have attached very little importance to the direction of the manipulations, and when circular kneadings have seemed easier to perform I have used them preferably, and also in many cases, *e.g.*, in pannus or in cloudiness of the cornea, have quite simply kneaded the anterior part of the ball with the eyelid from side to side.

In many (and in most) cases one should remember in massaging the eyeball that if on the one hand there can be no question of

* Dr. Kiær of Copenhagen has written a treatise on " The Value of Mechano-Therapy in the Treatment of Diseases of the Eye " (1885), and it is a pleasure to me to acknowledge the great use I have made of this work, though my opinion in many respects differs from that of Dr. Kiær. On the whole massage has done well in ophthalmic surgery, generally in medical hands.

strong pressure here for obvious reasons, on the other hand, in some pathological conditions, a certain amount of pressure is necessary to produce any effect. It is necessary to produce reabsorption of infiltrations and formations due to exudations and to induce retrogressive changes in more or less organised new tissues, and one often has to deal with changes of very long standing. In such cases gentle kneadings are of no use, and if one bears in mind all the contra-indications and is careful to produce no irritation of the iris, there is no danger in using a moderate but definite pressure. Marked hyperæmia is temporarily produced; this does no harm, but in its turn assists the process of absorption.

Massage of the eyelid is often performed in the same way by kneading it against the eyeball. If it is a question of changes in the edge of the eyelid, this is kneaded from the external to the internal canthus. When the changes were of such a nature that I wished to use strong pressure, especially when the upper lid was affected, for example in trachoma, I massaged with the tip of the little finger (smeared with yellow ointment or some other agent) inserted between the eyelid and the eyeball with the dorsum of the nail turned towards the latter, and then massaged the lid between my little finger and the index finger of the other hand, performing kneadings with the little finger in the conjunctival sac and using the index finger outside as support. The method has this advantage, that it admits a much firmer pressure than any other; the massage is also very much more effectual; the patient after a little time can bear this by no means painless manipulation fairly easily. A short, rather flat glass rod, rounded at the end, is also well adapted for massage in the conjunctival sac. Kostomyris of Constantinople has directly massaged the conjunctiva of the everted eyelid, using the little finger covered with boracic acid, and gives his results as excellent (surprising, to say the least of it). Some use paper capsules for kneading the conjunctiva palpebrarum, when each must be used only once. Others (with Neustätter) use wooden rods wrapped in cotton-wool.

Maklakoff in 1893 introduced vibrations in ophthalmic treatment. For diseases of the eyeball he gives vibrations either directly upon it or over the closed upper lid by means of Edison's instrument; the little ivory button attached to a feather spring performs 9,000 small vibrations a minute. Piesbergen uses a similar electric vibrator, in which the number of pendulum swings, usually about 2,000 a minute, can be increased or diminished.

The vibration therapy of Maklakoff has been used in *blepharadenitis* and *ulcers of the eyelids*, in *ulcerating keratitis*, *leukoma*, *serous iritis*, *irido-cyclitis*, *glaucoma*, and *traumatic cataract*. Pies-

bergen has used his vibrator in the above complaints, but chiefly for *chronic irido-chorioiditis* and (especially in syphilitic) *chorio-retinitis*, *hæmorrhage in the macula*, and *optic atrophy following neuritis*.

Domec (Dijon), especially in hypermetropia, but also in myopia, uses massage, performed by placing the tip of the thumb over the upper lid against the middle of the cornea, while the other fingers rest upon the patient's temple, and performs a series of pressures (about 100 a minute) for five minutes at a time. Darier, who has done much for eye massage, commends the method, the good effects of which he explains by the stretching of the zonule of Zinn, and the mechanical effect upon the lens, the toning up of the ciliary muscle and accommodation, and its influence upon the vessels and circulation. Domec's massage is used with good results for (primary and secondary) *glaucoma*, and considerably increases the effect of iridectomy, which of itself is insufficient.

Eye massage (except in the case of Maklakoff's vibrations) is usually combined with medical treatment in that some ointment is used in massaging ; and of these there is a veritable embarras de richesse. One must be careful in making a choice. Fresh lard and lanoline are good. The best vaseline is the *white* American vaseline. Yellow ointment as well as a mixture of yellow wax, cold cream, and oil of almonds have their warm adherents. Paraffin ointment is a firm substance consisting of four parts liquid paraffin and one part solid paraffin ; it has the disadvantage of being rather hard.

To these constituents are added different substances. I would mention first yellow precipitated oxide of mercury. The yellow ointment thus made is used of a strength from 1 in 200 to as much as 1 in 10. Löwegren of Lund recommended yellow oxide of mercury 0·2, cold cream 2. Iodide of potassium ointment, introduced by Heisrath, is also commonly used (pot. iod. 1, sodæ bicarb. 0·5, white vaseline 10). Grey ointment containing equal parts of vaseline and mercury is also in common use. Mitvalsky uses ung. hydr. ciner. 3, white American vaseline 6, purified lanoline 3. Protargol, a silver albuminate, is used by Emmert in 5 to 10 per cent. ointment with vaseline or lanoline in blennorrhœa due to dacryocystitis (but not with eczema or erosions), and by Darier in blepharo-conjunctivitis, partly in a 10 per cent. solution, partly as an ointment (protargol 1·5, zinc oxide 1, starch 1, vaseline 15). Darier advocates protargol as a specific (with massage) in chronic conjunctival blennorrhœa. Protargol seems to have been most successful especially in conjunctivitis and keratitis of different kinds ; it is used in solution 2 per cent. to 10 per cent. Sublimate

ointment is fairly common (0·003 : 10); ichthyol ointment is also used by some. Arlt of Graz massages for trachoma with a cupric oxide ointment with 5 to 10 per cent. citric acid.* Elsching massages at first daily, later every other day and every third day, either with the fingers or with a glass rod and cotton-wool saturated with a solution of oxycyanide of mercury 1 : 4,000. Boracic ointment is still used by many (2 to 3 per cent.). One can also massage with cocaine or eserine ointments. At present, however, the yellow precipitate ointment is used more than any other for eye massage.

Subconjunctival injections, which are now used for their disinfectant and absorbent effects, are usually followed (except when tuberculosis is present) by massage. In diseases of the cornea, iris, corpus vitreum, optic nerve, retina, and chorioid one of the following injections may be given as close to the equator of the eyeball as possible :—half or even a whole syringeful of distilled water, sublimate solution, 2 to 4 per cent. salt solution or sodium iodide solution, 1 per cent. solution of hetol (= sodium cinnamylicum), or a solution of cyanide of mercury ·01, chloride of sodium 1, sterile distilled water 50 (Darier). Specialists appear to differ as to the amount of lotion injected, the number of injections and their composition. But the great majority of them use massage after the injections, with the tip of the middle finger performing light, quick kneadings on the outside of the upper eyelid.

In explanation of the physiological effects of eye massage there is not much to add to what has already been said. The eye fluid is filtered mostly through the vessels in the sclero-corneal margin (venous plexus in the canal of Schlemm); the blood stream in the vessels is accelerated, although for anatomical reasons not very strongly; pathological tissue elements undergo retrogressive changes and are absorbed, vaso-motor and other nerves and the cells are mechanically stimulated. Besides the effects upon the circulation, absorption, etc., so often pointed out (and in many cases the strengthening influence on the orbicularis), eye massage also lowers the intra-ocular pressure for a time, which diminishes quite apparently owing to the flowing away of the liquids (Pagenstecher); according to Kiær the diminishing of the pressure after two minutes' massage may take two to three hours to be entirely equalised.† Reibmayer states that when one eye is massaged one notices at first a reflex dilatation of the pupil of the other eye, that this dilatation is quickly replaced by a contraction, and that at the

* For further details I refer the reader for the very various substances to Ohlemann's "Neueren Augenheilmittel": Wiesbaden, 1902.

† According to Ovio, massage of the eyeball has scarcely any effect upon the circulation or its metabolism. I can scarcely believe this opinion to be correct.

end of three minutes the pupil of the eye massaged is more strongly myotic than that of the other eye, even if both eyes have been closed during massage and are opened at the same time (which the reader will often find it difficult to notice).

Contra-indications are those generally referred to. In my first Swedish massage book (as in the German) I mentioned iritis and irido-cyclitis as constituting absolute contra-indications to all massage of the eye, as ever since my student days I have been accustomed to consider the absence of all irritation to be of the utmost importance in these diseases. I have since learned, however, that a well-known oculist, Dr. Bœkmann (Minneapolis, Minnesota), considers massage to be of great importance *during the later stages* of serous or plastic iritis or irido-cyclitis. "Massage," he says, "has only a good effect in irido-cyclitis when the eye is able to bear the manipulations, and one ought to be neither too sparing nor too gentle with the finger." Conscious of my own lack of experience, I give Bœkmann's opinion, and only draw attention to the fact that it refers to the last stages of the process, when the violence of the symptoms has subsided. One must always be careful not to persist obstinately with this treatment in those cases where it produces continuous violent injection of the vessels or other symptoms of irritation; it is a fact that some patients react violently to massage, and for them it would be an unsuitable treatment when for others it would be indicated. In eye massage one must always be most attentive and careful, and follow the case in every detail. If such treatment is left to any other than a doctor, who has at least his knowledge of ophthalmology to help him, this other should by preference be the patient himself. Similarly, in cases of corneal opacities in children I have once or twice taught (carefully and by means of several lessons) quite uneducated, though capable and intelligent, individuals how to perform the massage, which in these cases must often be persisted in for several months, involving great waste of the doctor's time.

Diseases of the Conjunctiva.

Chronic Catarrhal Conjunctivitis.*

The conjunctiva is rather red, in milder cases or in children often smooth or a little swollen; in more severe or older cases hypertrophic,

* As this work is partially intended for medical students who have not yet completed their ophthalmic studies, I give in every form of the disease mentioned in this chapter a short summary of the most important symptoms. Under ordinary catarrh are included here both the so-called chronic hyperæmia, distinguished from it by many authors, which is related to the more developed catarrhs by innumerable transitional forms, and the more severe form in which swelling of the follicles is the most apparent symptom.

thickened, and velvety. Occasionally one sees in the transition part small round red or yellowish pale lumps (= C. follicularis). The secretion is variable, often inconsiderable, the eyelids being merely glued together on waking. There is a feeling of weight in the eyelid, of itching, burning or pricking pain, or as if there were a foreign body in the eye, and rainbow colours around any light (owing to mucus on the cornea). Milder forms usually go for ten years or more without greater changes ; more severe forms may cause blepharitis, eczema, eversion of the lower punctum lacrymale, ectropion, blepharophimosis, etc. It usually attacks adults.

Kiær is, so far as I know, the first who has treated these diseases with good results by massage, which is of great value combined with the usual astringent collyria, cauterising, bathing, hygienic measures, etc. Kiær for this uses only vaseline. Hirschberg, who massages directly on the conjunctiva, uses iodide of potassium ointment ; Motschulsky, who specially recommends massage for thickening of the conjunctiva, uses boracic acid. Follicular conjunctivitis, which form many consider to be more like trachoma than like catarrhal conjunctivitis, is treated by Heizberg massage with iodide of potassium ointment, immediately upon the mucous membrane of the everted eyelid.

Acute Blennorrhœa of the Conjunctiva

= the dangerous purulent gonorrhœal conjunctivitis has for many years been treated by Schmidt-Rimpler by massage, for severe chemosis and œdema in the eyelid, along with other treatment, usually after incising the external commissure, during the early days of the disease and in its most acute stage.

Burchardt advises as quite the best for this disease a treatment of which massage forms a most important item. He condemns ice and cold compresses, leeches, and scarification. Instead he tells an assistant to inject a solution of 0·8 silver nitrate in 500 distilled water into the inner corner of the eye, while he himself performs *gentle* quick kneadings, with the thumb of one hand on the under eyelid and with the first and second fingers of the other hand placed upon the upper eyelid, for one minute four times a day. Between times a compress is used made of 5 per cent. chlorine water.

Croupous and Diphtheritic Conjunctivitis.

According to Ohlemann, among other treatment of these diseases is included massage upon the everted conjunctiva with 3 per cent. yellow precipitate ointment.

Spring Catarrh* (Sæmisch)—Summer Conjunctivitis (Schweiger)—C. Marginalis Hypertrophica (Pagenstecher)—C. Æstivalis (Hansen-Grut)—Hypertrophie perikératique (Desmarres).

These in a developed form present a quite characteristic picture in that the palpebral conjunctiva of the upper eyelid is covered with a mass of smooth granulations separated from one another by narrow, deep grooves (so that it has an appearance which has been compared with paving). In the bulbar conjunctiva there arises an infiltration, either in the form of isolated small, rather hard lumps, or in a long stretched yellowish elevation. Over the whole conjunctiva there is a whitish film like a thin milky membrane. The disease is principally one of youth, and lasts a long time, the subjective symptoms (itching, sensibility to light) quite disappearing during the cold season of the year, and the objective symptoms going back somewhat (though not nearly to the same extent), chiefly because the hyperæmia diminishes. The disease lasts several years, but usually entirely disappears leaving no trace.

Pagenstecher, Klein, Schenkl, Darier, and Michel have treated this interesting form of conjunctivitis with remarkable success by massage, which is the more worthy of consideration because the former customary methods, collyria, cocaine (to counteract itching), surgical removal of the granulations, etc., have been practically ineffectual. Pagenstecher massaged with a 10 per cent. yellow precipitate ointment, gave two treatments daily, and in a short time brought about recovery in the most obstinate cases. According to Darier, who for the rest praises massage in these cases (with lanoline-mercury ointment), the papillary excrescences on the tarsal conjunctiva show themselves strongly resistent to treatment; they are certainly best attacked by massaging, as I recommended with regard to trachoma, with the little finger of one hand in the conjunctival sac, or with a short glass rod placed there, and with the index finger of the other hand as a support outside the eyelid. Michel massages every other or every third day, with the finger on the upper eyelid, in gentle quick kneadings for at least five minutes, and uses for this sublimate ointment (hydrarg. perchlor. 0·003, white American vaseline 30).

Granular Conjunctivitis, or Trachoma.

Trachoma is an infectious chronic conjunctivitis, causing hypertrophy of the conjunctiva, with the formation of a velvety development of papillæ on the tarsal conjunctiva and of characteristic greyish round elevations, so-called trachoma granules, especially in the fornix. On further development there are changes in the conjunctiva of the eyeball, which

* Ophthalmologists are giving up the original name "spring catarrh," on the undeniably good grounds that, in the first place, the catarrhal symptoms are very slight; in the second place, the disease does not specially belong to spring, although the symptoms are then exacerbated.

becomes the seat of a chronic hyperæmia and hypertrophy; also the cornea is covered over with a more or less thin vascular membrane (pannus). The changes in the eyelid often lead to scar formation and shrinking, inversion of the eyelashes (trichiasis) and of the margin of the eyelid (entropion), which, however, may be turned outward (ectropion). The cornea becomes ulcerated, and may give way to the intra-ocular pressure (staphyloma of the cornea). The conjunctiva of the eyelid and of the eyeball may become adherent from the fornix (posterior symblepharon), or the conjunctiva may cease to secrete and become dry (xerosis). The final total destruction of the functions of the eye is not uncommon.

After the most acute stage and before shrinking has taken place trachoma belongs rightly to the "massage diseases" *; the treatment requires great patience on the part of both doctor and patient, but it is not a thankless task. No very considerable results are, however, obtained without strong frictions, so strong that they cannot be applied over the eyeball. Keining and Klein recommend kneading the conjunctiva of the everted eyelid with a swab of cotton-wool dipped in sublimate solution (1 : 5,000 to 1 : 2,000). Michel uses sublimate vaseline (0·003 : 10). Ottava of Budapest massages with a spatula of ivory, indiarubber, or wood. I recommend a glass rod and the method spoken of above of massaging the eyelid with vigorous kneadings with the little finger of one hand placed in the conjunctival sac, with the nail against the bulb, and exerting the necessary pressure with the forefinger of the other hand on the outside of the lid. I have generally used for this a 10 per cent. yellow precipitate ointment.

When this apparently rather brutal method is persisted in, and strong, necessarily rather short séances of three-quarters of a minute on each eyelid are given, one sees after weeks or months the extremely obstinate trachoma granulations becoming flatter and diminishing and finally quite disappearing. Similarly, the

* Trachoma has been massaged for a long time, but the literature concerning the result of the treatment varies enormously. Hirschberg and Heisrath take up an intermediate position between extreme scepticism and extreme enthusiasm. The former, as early as 1883, recorded very good results obtained after the acute stage, but before advanced changes in the tissues had arisen (iodide of potassium ointment); on the other hand, he does not recommend treatment where there is shrinking. Motschultsky considers massage in trachoma to be of secondary importance. Kiær only obtained any result in one case out of thirteen. Rohmer of Nancy has apparently a good opinion of the treatment. Costomyris is foremost among the large number of enthusiasts for massage; he maintains that he has cured several thousand cases of trachoma by massaging directly on the conjunctiva (with the eyelid everted) with boracic. Usually the "cure" took five to ten days, and was never longer than forty days!

Costomyris's enthusiasm for eye-massage is shown in that he recommends it for follicular conjunctivitis, chronic catarrh, phlyctenular conjunctivitis, spring catarrh, croupous conjunctivitis, diphtheritic conjunctivitis, blennorrhœa of the conjunctiva, scleritis and episcleritis, parenchymatous keratitis, and for corneal opacities. As long as I continued massaging trachoma by kneading the eyelid against the eyeball my results remained almost entirely negative; when I used Costomyris's method they became somewhat better, but still remained bad; when I finally went to work in the manner described above I obtained good, though still slow, results.

papillary hypertrophy diminishes, the scars become thinner, secretion becomes more normal, whether there was too much or too little, the conjunctiva shows altogether a much healthier appearance, and, as a result of a somewhat scanty but, as I hope, well-utilised experience, during which I compared various methods for the same case, I believe that in this way one may obtain quite good results, and better than by other methods, in those cases which are not too far advanced and before shrinking has set in. For changes on the eyeball, especially pannus, one massages afterwards or beforehand in the ordinary way with and through the eyelid, and with yellow precipitate ointment. Even when one proceeds in the above way, which I am convinced is quite the best method of treating trachoma by massage, in advanced cases one must warn the patient that months may pass before real permanent benefit is obtained.

Phlyctenular Conjunctivitis (Strumous).

On the conjunctiva of the eyeball in the region of the limbus (sometimes on the cornea itself = phlyctenular keratitis) are to be found one or more round elevations as large as (pustular) or smaller than (vesicular) hemp seed, or small miliary efflorescences consisting of collections of white cells and (on the conjunctiva) of lymph immediately beneath the epithelium. The condition begins with vascular injection, intolerance of light, pain, cramp in the eyelid, and lacrimation. Sometimes it vanishes leaving no trace, but it may give rise to ulcers owing to the breaking down of the phlyctenulæ. It arises usually in scrofulous children (see Phlyctenular Keratitis).

Many doctors have treated this common complaint by massage, and have thus to a certain extent improved upon the good results of the usual anti-scrofulous internal treatment by means of hygiene, calomel or yellow precipitate ointment. Kiær has compared the different methods of treatment using in twenty-seven cases massage only, in twenty-seven other cases precipitate ointment with out massage, and in twenty cases massage with precipitate ointment. In the case of "pure" massage the time necessary for treatment lasted eight or nine days; when the precipitate ointment (1 : 40) without massage was used the time of recovery took six days; when massage with ointment was used the length of time decreased to five days.*

* These statistics, without being quite valueless, are not sufficient to allow us to draw any definite conclusions when it is a question of such a variable disease as phlyctenular conjunctivitis. Personally the general opinion of Kiær and other thoughtful, observant, and experienced ophthalmologists, *e.g.*, Pagenstecher, that it is possible to improve the results by introducing massage, is to me of greater value by far than any number of mere statistics.

The subjective symptoms disappear under this treatment extremely quickly, often after one treatment.

Friedmann had two cases, Kiær one case, all three belonging to the vesicular kind with rather large phlyctenules, in which massage was not well tolerated and the injection and pains became more severe.

In all these forms one must use very gentle pressure during quick kneading, and preferably perform these as in Pagenstecher's radiating massage. This quickly causes the loosely-formed phlyctenules to absorb.

General treatment with fresh air, salt-sea baths, cod-liver oil, iodine and iron is naturally far more important in scrofulous ophthalmia than eye massage, which only deals with the local changes temporarily. (For a more complete account of the value of massage treatment of scrofulous ophthalmia, see Phlyctenular Keratitis.)

Darier praises the use of massage in *pterygium*.

Subconjunctival ecchymoses are quickly absorbed by massage (Schenkl, Klein).

Diseases of the Cornea.

Opacities.—It was for opacities of different kinds in the cornea that massage was first used in modern ophthalmic surgery, and it is in this condition that we at present best know its value. Here too we meet with the usual great differences in regard to the estimate of its value. But on the whole all who have used massage for this condition, without letting themselves be discouraged by one or two negative results in difficult cases, recognised its power of strongly assisting in reabsorption of spots on the cornea after keratitis of different kinds. The prognosis, even if considerably improved by massage, naturally follows the old rule that the more external, the thinner and the fresher the obscuring spots are, and the younger the individual, the easier and more possible is it to obtain complete clearness. As a general rule I may state decidedly that even quite small spots, nebulæ, nebeculæ, maculæ, or whatever they may be called, usually require several weeks, often months, of work before they vanish; deep, old, well-nourished leucoma remains unaffected by massage as by other treatment. The foremost ophthalmologists of the present day, however, strongly believe in massage in these cases, and Michel, for example, states that, combined with calomel and yellow ointment, it is our best means of treatment.

The mechanical irritation due to too strong massage may cause

the recurrence of parenchymatous keratitis which has been arrested. Hirschberg utters a warning on the subject.

In parenchymatous infiltrations of syphilitic origin massage undoubtedly has some effect, but general anti-syphilitic treatment is of far greater use. They can be quite suitably combined, and for massage it is best to use lanoline-mercurial ointment (which Darier, Malgat, and others recommend also in other cases of eye massage).

Massage should be performed by means of not too gentle kneadings, the direction of which is of minimum importance. But it is of the greatest importance that while the front of the eyeball is kneaded through the eyelid the patient should keep the gaze directed so that the kneading is performed upon the cornea.

Besides massage other means than those generally indicated in cases of opacities of the cornea need seldom be used. Dantziger in four cases first used abrasion either of the epithelium only or including also a layer of the corneal tissue, and about a week later began massage.

Pannus.—By this name is generally understood a membrane rich in cells and vessels and finally becoming an organised membrane of connective tissue between the corneal epithelium and the anterior elastic membrane. It is due either to trachoma or to phlyctenular conjunctivitis. It is treated by many with massage whether it is of trachomatous or scrofulous origin, and the results are naturally good in proportion as the pannus is fresh and less organised and has penetrated less into the normal tissue elements of the cornea. Massage now has become a strong rival of the old methods of inoculating blennorrhœa and of the newer methods of producing jequirity-ophthalmia, and has the advantage over these (both of which may get beyond control and cause perforation, panophthalmia, etc.) of not being dangerous. At the same time it has the disadvantage of being considerably slower, often producing satisfactory results only after treatment for months.

We attempt in this to bring about retrogressive changes in the numerous cells and small blood vessel walls as well as of all the newly-formed and more or less organised tissues. In order to bring about absorption we must maintain a strong hyperæmia,* and must therefore give as vigorous massage as possible, and may advantageously use a strong precipitate ointment (I have used 1 : 12). Schmidt-Rimpler recommends for trachomatous pannus Guthrie's ointment (silver nitrate 0·4, lead acetate lotion 8, white American vaseline 8).

* It is well to impress upon the patient beforehand that a condition of irritation is necessary and beneficial, especially during the early stages of treatment.

Combined with massage we can advantageously use cauterisation with bluestone, Paquelin's cautery applied to, or excision of, the blood vessels of the pannus, etc. On comparative research by E. Nordenson and myself we found that massage only, with yellow precipitate ointment, gave better results than blistering.

Finally, even some acute diseases of the cornea have recently been treated by massage with certain partial success. In all these cases massage must undoubtedly be used with gentle pressure and with a weak precipitate ointment.

Diffuse Parenchymatous Keratitis.

The results vary enormously, and massage for diffuse parenchymatous keratitis is only applicable after the acute stage is past.

Acute Phlyctenular Keratitis

has for a long time been treated by massage by German and French doctors (*e.g.*, by de Wecker and by Thea). Kiær has a small but careful comparison of seventeen cases, seven of which were massaged without any ointment and ten with precipitate ointment (1 : 40). In these cases also it is, according to Kiær, best to use precipitate ointment; the subjective symptoms disappear after very few treatments, the phlyctenules are quickly absorbed, and Kiær considers he has discovered a method of treatment which hinders ulceration and prevents permanent opacity of the cornea. It seems as if massage with precipitate ointment should be an improvement on the usual, fairly good treatment with calomel powder (with which many doctors not only powder the eye, but also massage it). General treatment must, of course, never be omitted.

When the symptoms of irritation are very prominent (injection, pain, photophobia, lacrimation), massage is not easily performed, and for my part I consider for this reason that it is better in these cases to let a day or two pass (according to Schmidt-Rimpler's advice) before beginning massage, and meanwhile use frequent boracic acid compresses and dilate the pupil with atropin.

Keratitis punctata superficialis (Stellwag, Fuchs) is included by Klein among the diseases of the eye which may be treated by massage.

Scar keratitis has been most advantageously treated with massage by Schenkl.

Superficial traumatic keratitis has been treated by Kiær with massage (very gently), using vaseline with good results, the pains, photophobia, etc., subsiding very quickly and the whole process of repair lasting only two or three days.

Diseases of the Sclerotic Coat.

Episcleritis (or the external form of Scleritis).

A circumscribed inflammation, arising often as the result of rheumatism, with infiltration and sero-fibrinous exudation in the external layer of the sclerotic (and in the deeper layer of the conjunctiva), often forming detached hard purplish lumps as large as a bean, between the cornea and the equator of the eyeball, and not movable with the conjunctiva, often extremely tender and accompanied by severe ciliary pains. They disappear after one or two months, leaving a greyish scar, and are apt to recur within the above limited area, but do not endanger the functions of the eye.

This not very common complaint lends itself to massage by its pathological-anatomical nature, and is also one to which Pagenstecher first applied such treatment with excellent results, which are all the more valuable since the other therapy (iodide of potassium, sodium salicylate, excision, scarification, scraping, etc.) was to the highest degree unsatisfactory. His experience has since been confirmed by German, French, and other doctors.

In the deep form of *scleritis* (connected with the above by intermediate conditions), arising for the most part in tubercular, scrofulous, or syphilitic persons, Pagenstecher used massage. As we know, this form does not give rise to distinct, definitely circumscribed nodules, but larger, only slightly-raised (purplish) swellings. It is much more dangerous than the previous form, because to a larger or smaller extent it weakens the resistive power of the sclerotic to intra-ocular pressure, so that ectasia, true staphylomata (so-called ciliary-staphyloma), arise, or the entire front of the eyeball, and with it the sagittal axis of the eye, is lengthened, with the result that it is followed by complications in the cornea, iris, and uvea ; opacity of the cornea, synechiæ, occlusion of the pupil, cloudiness of the lens and vitreous humour, etc., finally entirely destroy the functions of the eye.

One must, however, carefully investigate each individual case and not order massage under all conditions as a routine treatment, even when no general contra-indications are present. Two colleagues in Stockholm, Dr. Nordenson and Dr. Widmark, have both massaged episcleritis and scleritis respectively, and each informs me independently that in certain cases of scleritis he has obtained remarkably good results (with 2 per cent. precipitate ointment), but that in other cases quite uncomplicated in any way he has noticed the symptoms of irritation decidely increase and found himself compelled to stop all mechanical treatment. Even

A. D. Mansfield, who also obtained cures by massage twice daily (yellow ointment) and anti-rheumatic treatment, has seen similar cases with too strong reaction.

Under all circumstances it is here, as always, a *sine quâ non* for massage that there is no recent iritis present. Massage is done with yellow precipitate ointment. In many cases the external tenderness on pressure compels one, especially at first, to give very short and gentle treatments.* In any case, for this complaint, when only a sector of the eyeball is treated, one can make a rule of always using radiating massage.

Diseases of the Eyelids.†

Ectropion.

An abnormal position of the eyelid, usually the lower lid, which does not touch the ball with the whole of its mucous membrane, but to a larger or smaller extent is turned outwards in mild cases so that a small space is found between the eyeball and the inner border of the edge of the lid, in worse cases so that the mucous membrane of the eyelid is visible even to the fornix. Ectropion arises from scars in the skin, in conjunctival catarrh and trachomatous conjunctivitis, in ulcerating blepharitis, anomalies in the tear-duct, and as a result of senile changes in the tissues.

Kiær treated numbers of these cases by massage with marked success. Cicatricial ectropion, as can easily be understood, has a very much worse prognosis than non-cicatricial. Kiær obtained complete recovery only in cases which were the result of blepharitis, chronic conjunctivitis, or eczema; in one case of senile change there was only a slight improvement in one eyelid (both had ectropion). In cicatricial ectropion Kiær has in a few cases obtained some improvement after persevering work.

Massage is performed in long séances (five to ten minutes) and with vaseline, unless the disease seems to indicate the use of yellow precipitate ointment.

Abadie successfully massaged the orbicularis oculi in *blepharospasm.*

For *cicatricial deformities* in the eyelid Stedman-Bull has used

* Schmidt-Rimpler advises cocaine ointment in marked infiltrations ("Lehrbuch d. Augenh.," p. 50, 2).

† *Ciliary blepharitis*, inflammation in the edges of the eyelids, which become hyperæmic and swollen. The skin between the cilia becomes covered with small scales (squamous blepharitis). Small abscesses are formed in the hair follicles and sebaceous glands, which cause ulcers (ulcerating blepharitis); the edges of the eyelids are often greatly thickened (tylosis). Blepharitis is combined with chronic conjunctivitis; the ulcerating form causes loss of the cilia (madarosis) or turns them in (trichiasis); the increased weight of the eyelid in the hypertrophic form causes it to droop (ptosis); as a result of scar contraction the lower eyelid may become everted (ectropion).

massage preparatory to operation in order to make the tissues softer and more pliable.

Ohlemann reports good results from massage in *fissures* of the canthus.

Internal Diseases of the Eyeball.

In treatment of *cataract* massage now takes a place for several conditions. Junge, Chopin, Becker, and others order it to aid absorption *after discission*, just as it is used for infantile soft cataracts in order to bring about absorption of the mass of the lens by the action of the aqueous humour. When this operation is performed in the case of star-shaped cataract and the lens capsule has been opened, the lens may be brought out into the anterior chamber by kneading the sclerotic, after which it may be made to absorb by massage through the eyelid over the cornea. It is necessary to make sure of the absence of all irritation of the iris and to use careful manipulation. It must be remembered that massage without doubt increases the danger of iritis, already threatening to some extent.

V. de Laan used massage as aiding absorption in *traumatic cataract.* In one case with linear ulceration of the cornea and iris a large portion of the lens had been brought forward into the anterior chamber by means of the five-year-old patient's own kneading, and was absorbed there. The glaucomatous symptoms disappeared in twenty-four hours (" Centralbl.," 1881, p. 446).

*Massage of the Cortex, or Massage for the ripening of Cataract.**

Massage is part of the means by which one attempts to shorten the time which passes between commencing opacity of the lens, with consequent interference with vision, and the " ripening " of the cataract, or that stage when the lens can be most easily removed from its capsule without leaving any remains of its own cortical substance.

As is well known, it has been attempted to bring about complete obscuring of the lens by exposing it to the action of the vitreous humour by the discission of the anterior wall of the capsule. It has been attempted to reach the same goal by means of a preparatory iridectomy, which has an undoubted effect though difficult to explain.

It occurred to Förster of Breslau that preparatory iridectomy hastens total obscuring (*i.e.*, the ripening of the cataract), that the

* A good work on this subject is " Om konstgjord starrmognad " (Nordman, Helsingfors : 1885).

lens, when pushed forward by the movement of the aqueous humour, undergoes some change in shape, some movement of its small particles among themselves, and that the disintegration of these small particles of the cataract is consequently assisted. He considered that a similar movement between the elements of the lens could be promoted by means of massage performed on the lens over the empty chamber immediately after iridectomy. Upwards of 500 cases showed the correctness of his opinion, and the said massage of the lens performed in one treatment immediately after iridectomy in order to further ripening of the cataract was introduced under the name of "cortex massage" into ophthalmic surgery, in which its position is now established.

Förster uses massage of the cortex only for cataract with hard nuclei; for chorioidal cataract, which leaves a large part of the lens transparent and has no hard nuclei, and only consists of a thin opacity at the posterior pole, he does not consider it suitable. At the Congress in Copenhagen Meyer demonstrated (on a rabbit) that even a quite normal lens may be totally obscured by strong massage of the cortex, and considers that the method may be used also for chorioidal and generally for soft cataracts, for which it has already been used with good results by several eye specialists. The majority, however, are agreed that it works best in senile and nuclear cataracts. The method, however, has strong adversaries, among whom are Alfred Græfe and de Wecker, as well as Fuchs, who consider that ripening of the cataract is of little importance for the extraction of the lens, and therefore are not inclined to adopt means of hastening it. This opinion has of late years gained ground, and massage of the cortex is therefore little used now.

Massage is performed, immediately after the iridectomy (done under cocaine as an anæsthetic), with a squint hook, Græfe's or Daviel's spoon, a spatula or special little roller-shaped instrument (Meyer), performing kneadings over the cornea, or also, as so often for eye massage, by kneading the eyelid with the finger for about one, at the most two minutes, and afterwards dropping in atropine (not eserine, which increases the irritation of the iris). Förster waits for four to eight weeks, though most other eye specialists wait a shorter time, before the operation for cataract after a preparatory iridectomy is performed. But ripening takes place a few days after massage of the cortex; according to Meyer it is sometimes seen directly after massage of the lens. If the massage does not prove effective it may be repeated after a few weeks, and after puncture of the chamber, with greater vigour, or discission may be used for ripening of the cataract, or one may wait for this to occur

" naturally," or it may be dispensed with altogether and operation performed without.

Wicherkiewicz and Schnabel used massage for *simple glaucoma*, partly to reduce the intra-ocular pressure, partly (Schnabel) to counteract the accompanying cloudiness of the cornea. It is certain that it is possible to reduce intra-ocular pressure temporarily, the effects in this respect lasting several hours and then passing off. Schenkl found that they lasted twenty-four hours; in secondary glaucoma he found massage produced permanent improvement. Enterprising persons have attempted massage for inflammatory glaucoma, but it has not been tolerated by the patients.

Schenkl used massage with benefit for *hyphæma*.

Just (Zittau) by massage produced reabsorption of *hypopyon* (= exudation in the anterior chamber) in one case of serpiginous ulcer of the cornea, when the hypopyon, 3mm. high, disappeared after five treatments (twice daily with gentle kneadings), and Sæmisch's operation which had been thought of was therefore unnecessary. One must of course remember that an exudation in the anterior chamber may equally well originate from iritic as from keratitic processes; in the first case, as has been stated several times, massage is absolutely contra-indicated.

Pagenstecher used massage in a case of *disease of the ciliary body*, with the happy result of complete recovery after fourteen days. The disease he considered to be a limited exudation round a ciliary nerve. Even Klein is inclined to use massage for " substantive " ciliary neuralgia (" Centralbl.," 1882, p. 159).

Mauthner, Hirschberg, Priestley-Smith, Mules, Perles, and others order massage for *recent embolus in the central artery of the retina* (usually in arterio-sclerosis and in elderly persons, sometimes also in young people with heart disease). It is only when one gets the case before twelve hours after the sudden blindness that one may expect anything from massage, which in these cases should be performed over the eyeball for some time. In Hirschberg's clinic this is massaged twice daily " externally " for as long as fourteen days, making the patient direct his gaze so that the position of the embolus may be reached as much as possible. According to Mauthner, one should cut open the conjunctiva, insert a hook into the optic nerve, and massage the posterior part of the ball. R. Fischer massaged for over three hours with short breaks. It seems as if the introduction of massage to a large extent brightens the otherwise dismal prognosis in such cases of embolism, as various cases of reabsorption due to this treatment have now been recorded.

Disease of the Orbit.

Tenonitis (of the right eye), or that disease to which this name is usually applied, was treated by Gradenigo * with massage. The case presented marked exophthalmos and a hard, resistant prominence of the whole orbit, swelling of the eyelid, chemosis, severe pains, insensibility of the cornea, immobility of the eyeball, no perception of light, besides general lassitude and repeated attacks of fever. The symptoms had gradually developed in an otherwise entirely healthy woman, who was taken into the clinic to have her eye enucleated. Luckily massage was tried first; it immediately produced improvement, and "after a short time" complete recovery. Both Scellingo and Klein have used massage with good results in a case of tenonitis. It is also reasonable to believe that in these cases massage is able to hasten the removal of the symptoms, which certainly, even without treatment, often give way fairly soon. Before beginning the treatment one must, however, in the usual way (stated in all text-books on ophthalmology) make a differential diagnosis from orbital cellulitis, and from panophthalmitis or thrombus in the cavernous sinus.

* * * * *

I must draw the attention of the reader in a special note to this chapter to the importance of massage for a number of anomalies in the eyes which arise from overflow of impulses, or reflex processes beginning in other peripheral parts. It has long been known that eye symptoms may arise in this way, and the more complete knowledge of extra-ocular pathological-anatomical causes for such symptoms has to some extent helped to limit the number of the cases considered as purely "eye neuroses," a limitation which has taken place for similar reasons in other directions.

It has for a long time been known that inflammatory conditions of irritation in the teeth or in the cavities of the nose and ears or in the genitalia of women are able to cause complex eye symptoms which in earlier days would have been considered as primary diseases of the eye. Similarly, we know that neuritis, particularly in the ophthalmic division of the trigeminal nerve and its branches, may cause similar phenomena. For this reason many have connected supra-orbital neuritis (or neuralgia) and migraine with its frequent eye symptoms. It is important to remember that neuritis or perineuritis may only be partial phenomena in more extensive subcutaneous, so-called "rheumatic,"

* Atti del associazione ottalmoligica italiana, sessione di Padova, Settemb., 1882 (*Annali di Ottalmologia*, 1883; quoted by Kiær).

chronic inflammatory processes. Lastly, it has recently been stated by several doctors, quite independently of each other, that they have noticed that similar changes in the muscles of the head and neck (occipito-frontalis, temporal, sterno-cleido-mastoid, and trapezius are mentioned by Rosenbach) may cause the same sensory and functional disturbances in the eye.*

The eye symptoms which usually arise from central impulses from extra-ocular, more or less remote, foci of irritation are pain, sensitiveness to light, scotoma, weight in the eyelid, hyperæmia, lacrimation, even chemosis. The most usual seem to be indefinite pains in and around the eyes and asthenic trouble when reading. The case may resemble an attack of migraine in that it has exacerbations, still more than the nervous or hysterical cases, and there is also a muscular or accommodative asthenopia, this last especially in combination with anomalies of refraction, such as astigmatism or hypermetropia.

Moreover, in my opinion, which still needs confirmation from the experience of others, peripheral infiltrations may even produce motor reflexes, especially over the centre of the facial nerve, and in this way cause blepharospasm.

From the above it may be seen that with these sensory and functional disturbances in a patient's eye it is often a complicated task to make a diagnosis. One ought first to examine for a number of eye diseases, above all for anomalies of refraction, and for accommodative and muscular asthenopia, and bear in mind general causes (chlorosis, anæmia, neurasthenia), intracranial processes of different kinds, not forgetting the purely nervous asthenopia (Förster's copiopia hysterica); and one must further carefully examine for foci of irritation in the mouth, nose, ears, or in the female genitalia. Externally one should palpate the head in the manner already described, especially the forehead over the supra-orbital nerve, looking for rheumatic infiltrations and neuritis, as well as for myositis, especially in the above-mentioned muscles.

* In the year 1884 I had in my own practice a case of a young woman who, without other objective changes in or outside the eyes, suffered from pains in the eye and asthenic trouble, with simultaneous widespread double-sided infiltrations in trapezius. The muscle infiltrations yielded to massage and the eye symptoms disappeared without other treatment. The patient herself, as is often the case, considered that the two were connected. I did not at that time know of any other observation, and dared not draw any conclusion from one case. Some time after I saw one or two cases which reminded me of the above. I heard then from Dr. Widmark in Stockholm, to whom I stated the case, that he had just then seen a similar case for the first time. Since then, in a treatise on "Eye Symptoms from Peripheral Trigeminal Affections" (*Nord. Ophthalm. Tidskrift*, 1889), he tells us that he has met with various interesting cases, among which myositis may also be a cause of eye symptoms. Long after my own first observation I found that it was not at all new, as several ophthalmologists had made similar observations, and that Rosenbach had brought the subject forward before either Widmark or myself (see "Ueber die auf myopathischer Basis beruhende Form der Migräne" (*Deutsch. Med. Wochenschr.*, 1886), referred to, among others, by Hirt, p. 51, in "Patol. u. Therapie der Nervenkrankheiten").

Finally, one must never forget that several causes may be combined, and that when there are several pathological changes in one case it is impossible to say à priori which is responsible for the eye symptoms.

The use of massage is chiefly in those cases where subcutaneous infiltrations, neuritis and perineuritis or myositis are present, and can be got rid of in the way which has been described in several places in this book, and which I need not repeat. Similarly, massage may be used when pelvic diseases, *e.g.*, parametritic exudations, are to be found. The eye symptoms may persist even when the massage has cured the pelvic trouble, and one must then look further for the true cause of the former.

CHAPTER XVII.

THE THORACIC ORGANS.

A. The Heart.

In my chapter on walking (p. 156) *I have already referred to it as the best form of gymnastic exercise in diseases of circulation, respiration, and metabolism. Systematic prescribed walking on level and on sloping ground, here described under the name of*

Stokes' Terrain-cure,

is of much greater importance than any other gymnastic system because of its wide therapeutic use. Besides its smooth continuity, which exerts a constantly renewed effect, it has, as compared with exercise of any kind whatever performed in enclosed, often dark, stuffy gymnasia full of dust and bacteria, the advantages of fresh air, sunshine, and other vitalising influences. It is difficult for the gymnastic specialist, into whose sphere the terrain-cure has made a marked inroad, fully to appreciate it, and, prejudiced as he may be, he is supported by the common tendency of mankind to value the costly and the complicated rather than the simple and inexpensive. But the unprejudiced, broad-minded and clear-sighted physician will always prefer the Stokes' cure to gymnastics and gymnasia in all cases except those in which there is some definite reason for a different treatment. These cases consist largely of deformities, especially curvatures of the spine, the combined treatment of which by gymnastics, orthopædics, and massage has already been discussed; also of those cases where the joints other than the lower extremities require exercise; of the numerous cases in which inability to walk, or other external circumstances, place the terrain-cure out of the question; and, lastly, of cases in which it is no longer possible to exercise the heart or influence it by active gymnastics, and for which the constant supervision of the physician is indispensable.

In this chapter I refer only to diseases of the heart and lungs. But I must remind my readers that the terrain-cure, the external conditions and simple technique of which are stated, plays an important part in the treatment of dystrophies, especially obesity,

and that it affords the best possible form of gymnastics in the treatment of diseases in the joints of the lower extremities.

Walking, especially in mountainous tracts, has, as Bamberger remarks, been in use for long as a therapeutic measure, especially in diseases of the heart. *It was, however, the well-known clinician Sir William Stokes who (about the middle of the nineteenth century) first called attention to the fact that rational gymnastics, and especially mountain-climbing, can produce hypertrophic changes in and strengthen the heart just as exercise strengthens skeletal muscle, and who at the same time indicated the other necessary parts of the now well-known terrain-cure for heart disease.* Stokes, like Wunderlich, saw that a greater quantity of blood in the vessels entails greater work on the heart, and it was Stokes who first ordered restriction of fluid instead of the repeated venous bleedings previously recommended by Wunderlich in order to facilitate the functions of the heart and to diminish the abnormal amount of fluid in the blood vessels. Stokes also ordered a diet rich in protein in order to produce the desired hypertrophy of the heart. And, finally, it was again Stokes who formulated certain important contra-indications to the terrain-cure.*

A terrain-cure can, and moreover ought, in many cases to be conducted on level ground. In other cases to obtain the best results an ascent of 20° is needed, preferably spread over a considerable length. An ascent varying from 5° to about 10° or 12° is, however, the most useful and satisfactory in all cases, especially when the incline is fairly long. In several instances of diseases of the respiratory organs it is a great advantage if these inclines go through pine woods. In many cases of heart disease preference must be given to low or slight elevation over the sea rather than to high altitudes, where the atmospheric pressure is much diminished.

* In Stokes' " Diseases of the Heart and of the Aorta " (Dublin, 1854) we read (p. 357), for example, the following concerning treatment of fatty degeneration of the heart :—

" The patient must adopt early hours and pursue a system of graduated muscular exercises, and it will often happen that after perseverance in this system the patient will be enabled to take an amount of exercise which at first was totally impossible owing to the difficulty of breathing which followed exertion. . . .

" The symptoms of debility of the heart are often removable by a regulated course of gymnastics or by pedestrian exercise, even in mountainous countries, as Switzerland or the Highlands of Scotland and Ireland. . . .

" His (the patient's) use of fluid should be as sparing as possible."

Stokes, besides this, recommends a diet rich in protein, discourages all that has a lowering effect, and also points out the necessity of avoiding the terrain-cure for advanced cases of arterio-sclerosis, etc.

Professor Oertel, of Munich, who wrote in the seventies and eighties, added to this treatment nothing more than " heart massage," which is worthless because of its foundation on faulty physiological principles, and the equally worthless and absurd " *saccadée* " respiration during mountain-climbing, and his detailed treatise, which certainly has some value, does not add anything essential to what had already appeared in the pregnant utterances of the British author. With all due recognition of the great service rendered by Professor Oertel in spreading the knowledge of the terrain-cure, I maintain that his claim to associate his name with this cure is quite unjustifiable.

The technique of all terrain-cures is on the same basis and extremely simple. Especially with heart affections, it is well for the patient to understand the importance of those rules which are made in order to prevent him over-fatiguing himself. During my practice at Carlsbad (Böhmen), with its facilities for such cures, I have always found it necessary to enforce the three following rules on my patients :—

(1) *Patients must walk every day, preferably at two distinct times, separated by not too short a rest, on the prescribed terrain as far as they can without over-fatigue.* No one better than the patient can definitely limit the day's work to just below the fatigue point. It would be absurd to prescribe the length of each walk, which varies from day to day owing to numerous causes, all of which are out of our control. The power of walking increases, and the increase is in many cases so perceptible from one week to another during the treatment that the patient at the end of his cure is often able to undertake without any danger long walks, which at the beginning of his cure would have been impossible.

(2) *All patients who are undergoing the terrain-cure, but especially all heart patients, must avoid all temporary overstrain of the heart. This is best attained, in certain cases of heart disease, by the prohibition of too steep paths, and by forbidding the patient to walk so quickly as to produce dyspnœa.*

(3) *As a third rule in the terrain-cure I make it a custom to prescribe that the walk be taken early in the day and that all tiring movements be avoided at the close of day ;* this especially, because for several hours after mountain-climbing its effect on sleep is disastrous.

The "*saccadée type of respiration,*" which is partly used with Oertel's "heart massage" (see above), and partly in connection with terrain-cure, consists of expiration in two stages in time with the patient's footsteps, first ordinary expiration and directly after that a forced use of the muscles of expiration, which drives out a certain extra quantity of pulmonary air. Oertel has illustrated by figures that the ventilation of the lungs becomes greater, and he maintains that the cardiac impulse becomes slower, more regular, and stronger. This result, however, can be achieved without the "*saccadée*" respiration, which, besides being entirely useless, mountain-climbing by itself producing sufficiently deep respiratory movements, has the great disadvantage of introducing discomfort into the patient's walk.

* * * * *

Medical experience, especially in affections of the heart, varies considerably. In hospital practice a doctor often sees advanced cases of arterio-sclerosis, of severe endocarditis and pericarditis, and of lingering infectious diseases where one or other of these affections has caused myocardiac changes, which necessitate the

greatest care in physical exercise and, above all, cause doubt as to terrain-cures (p. 144). A great percentage of these heart cases are hampered by severe *cardiac incompetence*, so that all active and severe exercises are contra-indicated. These cases are also often complicated by severe inflammatory processes in the kidneys, which also contra-indicate hard physical exercise.

In a sanatorium the percentage of heart cases suitable for terrain-cures in which the heart is still strong enough to be treated by active exercises, and in which the kidneys are still normal or nearly normal in function, is much greater. Thither flock a number of individuals who, having weakened their hearts by alcohol or tobacco, have not arrived at that stage of advanced fatty degeneration which forbids both terrain-cure and all hope of a long and tolerably-comfortable existence. The patients suffering from obesity who undergo treatment, especially at alkaline-saline sanatoria, need the cure both for their obesity and also for the condition of the heart. Of those patients suffering from anæmia, as well as those who are recovering from severe infectious diseases, many are sent to the cure because of their imperceptible heart-beat, weak "distant" heart sounds, and small, weak, often uneven pulse, which symptoms are sometimes accompanied by an increased heart dulness, so that each patient according to his strength can exercise his heart, the walls of which are absolutely or relatively (to the dilatation) thin. Patients suffering from gout and mild cases of diabetes often receive great benefit from the terrain-cure, not only on account of gout or diabetes, and of the obesity by which these diseases are often accompanied, but also on account of the improved condition of the heart. And, lastly, institutions for the terrain-cure are often frequented by patients who have just such cardiac changes resulting from valvular disease as can be benefited by this excellent system of gymnastics.

Opinions concerning the terrain-cure and its use in valvular diseases are very variable, and I must here take the opportunity of referring to them somewhat in detail.

I think, however, that we all agree that the terrain-cure is most valuable and least dangerous in cases in which compensatory hypertrophy is not yet fully developed or in which, generally after many years' duration, it is incomplete owing to commencing fatty degeneration or other changes, but which have not reached a high degree of cardiac incompetence.

In most cases we have to do with the left auriculo-ventricular and aortic orifices. In *mitral incompetence* the heart walls hypertrophy on either side of the valves, and we thus find thickening of

the walls both of the left ventricle and auricle. This incompetence causes a stasis in the pulmonary circulation, and therefore hypertrophy develops in the walls of the right ventricle due to increased work. Riegel points out that *pure mitral stenosis* has an entirely different influence ; he says that it causes dilatation and thickening of the walls of the left auricle ; but the walls of the left ventricle, when the stenosis is not accompanied by any incompetence, are neither stretched nor thickened, but, on the contrary, changed in the opposite direction, viz., in the direction of concentric atrophy. But, as we know, stenosis and incompetence are generally associated and we find the walls of the left ventricle hypertrophied, both with disease of the mitral valves and with changes in the semilunar (aortic) valves.

In advanced cases of valvular incompetence, especially in the aortic valves, some doctors are so much impressed by the quick bounding pulse, by the fear of hæmorrhage, etc., that they are opposed to any other exercise than that necessary in daily life, or at least all therapeutic exercise other than walks on level ground. On the other hand, they are perhaps more inclined with stenosis to help the compensatory hypertrophy behind the stenosis, in order to lessen the stasis behind it and increase the lessened blood flow on the other side. Other doctors, and among these Oertel, hold an entirely opposite view ; they are more inclined to use the terrain-cure in cases of incompetence than in cases of valvular stenosis, and are especially afraid of prescribing too much work for the heart when there is stenosis of an auriculo-ventricular opening and when there is hypertrophy due to excessive work in the normally thin walls of the auricle of the heart.

Valvular incompetence and stenosis are too intimately connected and too often combined for us to make any great difference in the treatment of each. Neither do we in Sweden make any difference in our mechano-therapeutic treatment. As soon as we want to bring about or strengthen a compensatory hypertrophy, or, in other words, as soon as anything can be gained by exercising the heart, which is the case in all slight instances of valvular stenosis or incompetence, but not so in advanced cases of cardiac incompetence, we use gymnastics. It is well to repeat that we ought to prescribe the terrain-cure in all suitable cases where the patient has the opportunity of taking it, and where constant supervision is unnecessary. In the more severe cases we accentuate our prohibition of all over-fatigue, and allow only horizontal or quite gently inclined walks, and give emphatic warnings against any exercise so violent as to cause dyspnœa.

When it is not possible to use the terrain-cure the patient is sent to a medical gymnast or, if possible, to a Zander institute. In the

institutes in Sweden doctors send their patients for pure mitral stenosis as well as for pure incompetence, or for both combined.

Dilatation, fatty heart, and arterio-sclerosis place the doctor who firmly believes in gymnastic treatment for the heart in a quandary as to his choice of treatment.

Among the definite contra-indications to gymnastics we unanimously reckon *sudden dilatation*, which is very seldom seen as the result of over-strain caused by too strong physical exercise, apart from definite organic changes in the heart. *This sudden dilatation is really a partial rupture*, and is accompanied by acute symptoms of incompetence, etc., and is very liable to end fatally. Just as abstinence from violent exercise is the most important prophylactic measure, so is rest the most important means of treatment, and only after recovery can very careful gymnastics be used.

But in cases of *slowly developing dilatation* the case is altered on account of the increased intracardiac pressure and the weakness of the walls of the heart due to chlorosis, anæmia, or other prolonged and severe illness, when the cavity of the heart is enlarged, the walls being relatively or absolutely thin but otherwise healthy. In these cases nature strives constantly for hypertrophy, produced by the increased work of the heart in systole due to its increased contents. This hypertrophy, which is compensatory to dilatation and is very desirable, is hindered by a sedentary life, but it can be encouraged by a suitable mode of living with a moderate amount of exercise. But the dangers of over-strain are obvious, and a close consideration of the physical signs and of the symptoms, on which we lay great importance, and also of the intellectual and psychological characteristics of the patient, must decide if we should recommend a terrain-cure on horizontal and perhaps gradually on slanting ground, or if we should prescribe a gymnastic treatment at a Zander institute or elsewhere.

By the expression *fatty heart* we understand in Sweden two different conditions—either the extensive *fatty infiltration* in the connective tissues of the heart, or the real *fatty degeneration* of the protoplasm of the cardiac muscle fibres.

Gymnastics, especially the terrain-cure, gives excellent results in cases of fatty heart in obese patients, when the heart is merely mechanically hampered in its work by the extensive masses of fat in its connective tissue, but the muscle fibres, apart from any slight fatty degeneration resulting from the mechanical pressure of these masses, are for the most part healthy and normal in function.

Early fatty degeneration can also be counteracted in its first stages by active gymnastics, either in the form of systematic walks or by Ling's, Zander's, or other system.

But advanced fatty degeneration of the heart contra-indicates active gymnastics. The heart should not be treated by strong active exercises in the following instances :—After severe febrile (and other) illnesses ; towards the end of prolonged valvular disease ; in cases of abuse of tobacco and alcohol ; when the blood supply is diminished or the blood insufficiently oxygenated, or when some harmful substance (as alcohol in drunkards, β-oxybutyric acid in diabetes) is present in the blood ; or (in cases of valvular disease) when there is difficulty in the flow of blood and lymph from the heart ; when any of these conditions have produced extensive chemical changes in the muscle fibres—in other words, in all cases of marked loss of functional power and in high degrees of incompetence.

It is in such instances that gymnastic institutes are of use with *passive* exercises and massage, the former in the form of arm-rolling, leg-rolling, circle-turning, chest-lifting, etc., the latter in the form of arm-kneading, leg-kneading, abdominal kneading, chest-clapping, etc. This treatment gives *no* extra work for the heart, but by certain movements and manipulations aims at assisting the work of the heart, diminishing stasis, accelerating the circulation, relieving dyspnœa, and partly in a psychic way, mitigating the final sufferings of the patient. (See also what is said by Dr. Arvedson and Dr. Zander on the same subject.)

Doubtful cases where one fears that the terrain-cure, in which the patient necessarily is left to his own judgment, might cause paralysis or rupture of the heart, are suitable for treatment in medico-mechanical institutes and by medical gymnasts. In these cases, besides passive exercises and massage, one uses careful resistance movements for the trunk and limbs, especially the lower extremities, and, particularly in Germany, the slow self-resisted exercises.

To regard arterio-sclerosis without exception as a contra-indication to gymnastics is as unjustifiable as it is to exclude from gymnastics most people above the age of sixty. Only the severe form of arterio-sclerosis need be considered a contra-indication. Among the patients in the Zander institutes there is a large number of cases, especially men, suffering in some degree from arterio-sclerosis and its consequences, in which the heart can still be exercised, but for which the terrain-cure is considered too dangerous and constant supervision is necessary. In a great many slight cases the terrain-cure may be prescribed with advantage. In several cases of unmistakable arterio-sclerosis, when the functions of the heart were still fairly good and when most of my colleagues preferred using Zander's Institute, I have prescribed a terrain-cure. One must in such cases

rely on the patient's own judgment and the care he takes of himself and limit his walks to horizontal or slightly-sloping ground. By the nature of the case the therapeutic results are limited if arterio-sclerosis is somewhat advanced, but are often sufficiently good to satisfy both doctor and patient.

In advanced cases of arterio-sclerosis the terrain-cure is certainly out of the question, particularly when the disease affects the coronary arteries. We have often in such instances a marked fatty degeneration of the heart, which contra-indicates any treatment by exercise. Along with this in certain cases we find a definite blocking of the smaller arteries of the heart, and in consequence, often near the apex, numerous and widely-scattered softened patches (Ziegler's myomalacia). Or in consequence of this softening we find fibrous myocardiac changes, consisting of diffusely-scattered small solid masses of connective tissue, which occasionally cause real *aneurysm of the heart* and which are easily ruptured by increased intracardiac pressure. These conditions often give rise only to slight physical symptoms, although any exercise beyond the ordinary requirements of daily life is dangerous. This knowledge makes the cautious physician particularly careful and thorough in his examination, before he decides to allow a patient suffering from advanced arterio-sclerosis to undergo any treatment which necessitates work for the heart.

When one aims at strengthening the heart one must make use of other means besides gymnastics to promote hypertrophy, and exclude all influences leading to degeneration of heart muscle. Dietetic rules are therefore of the greatest importance.

In the first place one must forbid all abuse, and preferably all use of, tobacco and alcohol. Both are important, and tobacco is often as great a hindrance to a successful result as alcohol, none the less so because many more doctors use tobacco than spirits to excess and cannot, therefore, take an objective view of the subject. We all know, however, how much worse the prognosis is for an ardent smoker than for a non-smoker when the strength of the heart is in question, *e.g.*, in pneumonia, and " the smoker's heart " includes a " museum " of pathological anatomical changes. It is always easier for excessive smokers to abstain completely than to arrive at moderation, and the sudden breaking of the bad habit produces no inconvenience other than a marked degree of constipation.

One must be more cautious in making a sudden break in the patient's habits in regard to alcohol. But during the period of breaking off, a larger daily portion of alcohol should never be given than the amount corresponding to $\frac{1}{2}$ gram of absolute alcohol per kilo of body weight, and anything over $\frac{1}{4}$ gram per kilo of body weight in twenty-four hours is certainly harmful in the long run.

In every treatment which aims at strengthening the heart there should

be an ample supply of albuminous material. In the cases complicated by obesity, fat and carbohydrates should be moderately diminished; but one must remember that in all cases of heart weakness these diminutions must be *specially moderate*, and that the loss of flesh which a fat person undergoes by means of increased exercise, always within the fatigue limit, is more beneficial than that obtained by extensive dietetic limitations. Oertel's system allows 156 to 170 grams of protein, 22 to 43 grams of fat, and 71 to 114 grams of carbohydrate (see Treatment of Obesity).

When the frequent blood-letting of former times in heart affections was given up, and in its place it was attempted by diminishing the supply of fluid to counteract the disturbance in hydrostatic equilibrium and to bring into equilibrium the scarcity of blood in the arteries of the systemic circulation, with the corresponding overfulness in the pulmonary circulation and in the systemic veins, there was a tendency to regrettable extremes, due chiefly to German doctors and writers. Æsthetic reasons often induced these extremes in stout women patients. People not only ceased to follow the general instinct of drinking water at mealtimes; they often limited to much below normal the daily quantity of water taken. The results made themselves evident in a weak condition of the heart and nervous system, from which the patients occasionally did not recover, in loss of appetite and dyspeptic symptoms, and in extreme cases in sudden fatal termination from inflammation of the kidneys, even when the kidneys were healthy at the beginning of the treatment. (When they are unhealthy an intelligent doctor would hardly agree to the limitation of fluid below the normal.) In many cases after such treatment, ill-advised or badly carried out, I have seen gall-stones or renal calculi develop, but whether *post hoc* or *propter hoc* I admit could not be settled. One must also take for granted that this extreme limitation of fluid is injurious in gout or a tendency thereto.

With all this in mind I have never made use, either in the treatment of heart disease or of obesity, of extreme limitation of the daily quantity of water taken; I generally consider 15 c.c. of urine in the twenty-four hours per kilo of body weight as the daily secretion of urine to be desired. Neither have I prescribed abstinence from water at mealtimes, except in cases of cardiac incompetence, which may be known in their early stages by extreme *variations* in the quantity of urine passed, and in urgent cases give preferably small doses of digitalis corresponding to three to four teaspoonfuls per diem of our *infusion*, and for the rest tell patients never to drink much *at once*. Most of my cases of heart weakness, however, are mild ones.

Oertel adopted the limitation of fluid, as well as other points, from Stokes' treatment, and he cannot be exonerated from having carried this part of the treatment too far. It is worth while, however, to make oneself acquainted with Oertel's procedure, since, owing to the searching criticism he incurred, his views were fully developed.

At a certain stage of the disturbance of hydrostatic equilibrium in cases of fatty heart and other cases of cardiac weakness we find more or less definite œdematous swellings in those patients generally fat and pale, *who eat, and more especially drink, too much*. We have reason to believe that the blood in certain regions is very watery and that the whole

of the lymphatic system is over-full. We have, in other words, hydræmia and serous plethora. The flow in the lymphatics is rendered more difficult by the diminished elasticity of the tissues (= *verminderte Gewebespannung*), and *a diminished supply of fluid results in an increase in the quantity of urine.* It is in these cases that diminution of the supply of fluid gives the best result, the excess of fluid in the tissues is diminished, and palpitation and dyspnœa lessen or disappear.

In some other cases, which generally include early stages of heart failure with valvular disease, in patients *who do not eat, and more especially do not drink, too much,* and whose kidney functions are still healthy or fairly so, one can observe no local œdema. But a marked stasis takes place in the pulmonary circulation and in the systemic veins. It was in such cases as these that Bamberger and Lichtheim constantly found the blood in the outlying veins very concentrated, of high specific gravity, with increase of blood corpuscles and other solid constituents, a concentration which in hemiplegic patients is greater on the paralysed side (Penzoldt), the flow of venous blood towards the heart being unaided by muscular movements, and which diminishes and disappears under digitalis (Toenissen). Oertel points out that in these cases the lymph (infolge der gut erhaltenen Gewebespannung) flows easily towards the large veins, and that the quantity of fluid in these, in the pulmonary circulation, and in the arteries of the systemic circulation is not diminished, but increased. *If the intake of fluid is diminished in these cases the quantity of urine is not increased, but, if altered at all, is diminished.* Oertel considers that the total quantity of blood in these cases is not increased. It was cases of this kind, according to Oertel, that Lichtheim meant when in a fortunate hour at a congress in Wiesbaden he opposed the reckless limitation of the intake of fluid then in vogue. Oertel recognises that the effect on these patients of marked restriction of fluid is often bad, and contents himself with regulating it, and lets it be taken in smaller quantities. The quantity of urine varies markedly with the variations in the strength of the heart.

Oertel's third category consists of those cases in which the cardiac incompetence is advanced, in which the kidneys act badly, serous accumulations and extensive œdema are present, and the physical changes in the tissues (verminderte Gewebespannung) are extreme and hinder the lymphatic circulation. Marked stasis is present in the lymphatics, the venous blood in the systemic circulation is very concentrated, but the arterial blood in the systemic and all the blood in the pulmonary circulation is markedly thinned, so that the protein sinks from normal (at least about 72 : 1,000) down to 60 : 1,000. In these cases Oertel does not use Stokes' terrain-cure, but makes use of passive movements and massage to ease the circulation. He limits the intake of fluid in these cases, while giving digitalis and other diuretics, *if* the quantity of urine is thereby increased, but the water given is always divided into small quantities.

The most important conclusion one can draw from this is, to my mind, that the supply of water should be limited in those cases in which it has been too large and in those cases in which its diminution produces an increased flow of urine.

Lastly, many believe that in certain kinds of baths, especially in baths

with free carbonic acid after the Nauheim type, we possess important resources in heart affections. We have these baths, too, in Carlsbad, in which we use carbonic acid gas under different atmospheric pressures for different lengths of time and at different temperatures for the bath, beginning with slight atmospheric pressure, ten to twelve minutes' bath at a temperature of 33° to 34° C. every other day, and when it seems suitable we increase the atmospheric pressure to two, two and a half, or three atmospheres for twenty minutes every day and lower the temperature by degrees to 30°, 29°, 28°, or 27° C. An irregular, quick, feeble pulse becomes more regular, slower, and stronger during the bath and for the hours immediately following. For my part I consider these baths useful in neuroses of the heart, and will certainly not deny that they may have some value also in other cases. The intra-arterial pressure sinks *during the bath cure*, probably on account of the consequent widening of the peripheral blood stream. But the statements concerning baths which are made by doctors who presumably have often handled pathologically altered hearts are most astounding. For my part I should as readily believe in " spiritualism " as that the Nauheim bath could have a perceptible effect on the reabsorption of inflammatory products in the endocardium.

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There is no other *heart massage* worthy of mention than that consisting chiefly of different forms of tapôtement, as chest-hacking, chest-clapping, heart-clapping with the hand cupped " à l'air comprimé," heart-shaking, etc., which is commonly used, and which aims at and produces a slowing of the pulse when it is too frequent. In Sweden the procedure in this treatment often begins and ends with stroking over the heart region, including stroking from the axillary line to the front of the sternum without any very clear aim, and for the rest consists of the above-mentioned forms of tapôtement, which alone are really effective.

In most cases chest-shaking produces a slowing of the pulse, due to vagus reflex. It would seem to be uncertain whether the effect is more than temporary ; on the other hand, one may safely say that this " heart massage " is one of the least valuable forms of massage.

Professor Oertel, of Munich, has also in massage put forward impractical and ill-grounded propositions in reference to mechanical treatment in diseases of the heart. In combination with the equally absurd respiration saccadée used in his terrain treatment he allows massage to be performed by strokings which begin with expiration, go from each side of the chest in the axillary line at the level of the fifth and sixth ribs forwards to the seventh and eighth costal cartilages and xyphoid process of the sternum, and end, as soon as the hands of the masseur have reached the sternum, by his pressing it inwards with both thumbs, while with his other fingers he exerts pressure on the sides of the chest. By varying pressure such as is given in all massage he believes he can affect the heart in weak

conditions of the heart muscle, overfulness of the veins, and corresponding deficit of blood in the arteries, and where the work of the heart is increased (by valvular disease, tumours, struma, emphysema, kyphoscoliosis, etc.); also as an accessory to the terrain-cure.

With all respect to Professor Oertel, I must deny the value of this massage, and can only believe that incorrect opinions as to physical and physiological laws allow him to lay so much stress on this form of massage. *One* incorrect statement certainly is contained in the following quotation from his work: "Der Druck unter welchem die Expirationsluft während der Zusammenwirkung einer erhöheten Leistung der Expirationsmuskeln und der äusseren Pressung steht, und der sowohl auf der Innenfläche der Lungen und der Bronchialschleimhaut als auch auf der Herzoberfläche und der Oberfläche der grossen Gefäss-Stämme lastet . . ." That pressure which is present in the lungs and respiratory tract during expiration is a pressure entirely different from that which takes place in the thoracic space *outside* the lungs and the pressure which affects the heart. When the glottis is open there is a *negative pressure* in the thorax outside the lungs with ordinary expiration. During expiration this pressure becomes less negative, but in deep inspiration it can sink to as much as 30 mm. mercury below the atmospheric pressure. But the pressure never becomes positive, however deep the expiration. It is only in forced expiration that the pressure may become positive, apart from straining or closing the glottis. But if one agrees with Oertel in the possibility of influencing the heart by varying pressure with the hands outside the fixed ribs and through the soft, elastic, and yielding lung tissue which surrounds the greater part of the heart, as one influences skeletal muscle by massage, one should never allow such manipulation when pathological changes are present. The most experienced physician can never quite ascertain the condition of the heart in all its details, and it is quite impossible to exclude with certainty pathological changes in which such massage would be dangerous. *Oertel's massage is of a certain theoretical interest, but is of no practical value.*

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B. Diseases of the Lungs.

Under the influence of the terrain-cure, aeration of the lungs, as we have seen (page 101), is greatly increased by increase in the amount of the inspired and expired air, and the muscles of inspiration and expiration are exercised in the same way as other skeletal muscles by systematic work.

Besides the effect of the terrain-cure on the circulation and general nutrition, it has an influence on the chest and the whole respiratory apparatus, which obviously tends to counteract the development of the type of chest called "*poitrinaire*," thin-walled and flat, which we see in the predestined victims of tuberculosis. There is scarcely a physician who will not recognise the truth of these facts. But even in these days, when we establish at great

expense here and there in the country sanatoria for tubercular patients, it is nevertheless a rare exception for any doctor to make use of the many places to be found in the Scandinavian peninsula where suitable sloping ground, pine woods, and high altitude in combination invite him, not only to therapeutic, but to *prophylactic* activity against our most deadly disease. I think we commit in this way a terrible sin of omission against thousands of the nation's children with phthisical heredity and predisposition, whose health and power of resistance to this deadly disease could be improved by annual holidays with hill-climbing during their period of growth. It is certain that the development of the disease requires other conditions besides the existence of tubercle bacilli. In these cases terrain-cures accomplish so much more than medical gymnastics that I think the latter may be ignored.

The same holds good in cases of *catarrh of the air passages. Laryngitis*, *tracheitis*, and *bronchitis* are favourably influenced by terrain-cures, especially in mountainous districts clad with pine trees, high above sea level. It is not only the dry ozone-laden mountain air, free from bacteria, which is of so much therapeutic value in these cases. Amongst other ways in which the terrain-cure counteracts the tubercular tendency is that of causing hyperæmia of the lungs ; the more complete aeration of the lungs caused by the deeper respiration consequent on hill-climbing has also an important effect. These benefits, amongst others, may justly be credited to the terrain-cure.

Doctors who have had the opportunity of observing the effect of the cures in such health resorts in Austria, Switzerland, Germany, and the Scandinavian peninsula, or in Colorado in North America, which by the character of their terrain are naturally associated with the terrain-cure, have had good opportunity of verifying its strong curative effect even on the ill-omened *catarrh of the apex.* Many such patients still survive whose death from consumption might have been expected about ten years previously. Where excavating processes have developed one must, of course, take into consideration the increased danger of bleeding produced by strong active exercise.

In *emphysema*, as we know from Hanke, expiration in rarefied air is beneficial ; inspiration of rarefied air, on the contrary, increases the pulmonary incompetence and dyspnœa. I think, therefore, without considering that I have the right to speak as an expert, that if an emphysematous patient for other reasons requires the terrain-cure, or tries it for his emphysema, it should be carried out preferably at a moderate height above the sea level. In regard to the special forms of *asthma*, the results of mountain walks are so

uncertain and capricious that I feel unable to give a definite and detailed opinion.

Children suffering from *whooping-cough* who are treated by the terrain-cure, either before or after convalescence, derive great benefit both as to the disease itself and in regard to its sequelæ. This, however, holds good for change of air in general.

The treatment of *the results of inflammatory processes in the lungs and pleura* by active and passive gymnastics is satisfactory. Here we have to deal with a condition of *atelectasis* in the lungs, with *pleural exudations and adhesions between the visceral and parietal, especially the costal, layers*, and, lastly, with *deformities of the chest* produced by the prolonged presence of large pleural exudations. Amongst these deformities we must specially consider the difference between the lateral halves of the thorax following Estlander's operation of resection of ribs for empyema.

As soon as we have double-sided processes and conditions to deal with, the terrain-cure, besides being enjoyable in itself, excels all other kinds of gymnastics ; and a minute comparison between the respective results of the terrain-cure and of other systems can only redound to the credit of the former.

But when we have *one-sided* conditions to consider we must recognise the essential advantage of other gymnastic systems, especially of Ling's manual system, over the terrain-cure in that it can by special movements pay special attention to the affected side and can work strongly and exclusively upon that, while the terrain-cure only acts by influencing the whole chest by the larger respiratory movements. I have the less reason for entering upon a comparison between manual gymnastics and the terrain-cure, since, although I have observed the results of both systems, I have not myself carried out the manual treatment, nor have I investigated by suitable measurements of the chest and of its vital capacity the results which I have obtained time and again with terrain-cures after reabsorption of long-continued, large serous or sero-fibrinous pleuritic effusions, and even in one or two cases after resection of ribs for empyema. On the other hand, I can say from my own experience that even in these cases one can obtain surprisingly good results from terrain-cures intelligently conducted.

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Just as one can influence the heart by means of different forms of tapôtement on the chest and can produce slowing of the pulse by means of the vagus reflex, so one can also by suitable manipulations diminish dyspnœa due to cardiac or pulmonary incompetence, in the way I have described (page 50), by leading to more complete oxygenation of the blood and the reduction of carbonic acid.

I assume the possibility of aiding the reabsorption of exudations within the chest by different forms of tapôtement, especially by vibrations, although I have not myself made use of such a procedure or heard any other opinion on the subject.

As Oertel massaged the heart, so has Hünerfauth massaged pleural exudations after the cessation of the inflammatory process. So far as one can gather from the not very clear description, Hünerfauth performs this massage, when inflammatory products are present on both sides, by manually compressing the thorax on alternate sides in order to increase the pressure between the costal and pulmonary pleura, especially during inspiration. In the case of one-sided inflammatory products he massages " with the chest relaxed," and again during inspiration with one hand on the chest over the exudation, while the other hand exerts counter-pressure on the other side of the chest. Hünerfauth gives at first a ten minutes' treatment, and gradually leads up to two treatments of twenty minutes each. He had in this way several years previously " cured " four cases of severe " adhesive fibrinous pleurisy." The cure occupied six weeks, and was aided by gymnastics, douches, and cold water compresses. One wonders how the cure would have progressed with these latter means without massage ! I cannot prevent people believing in Hünerfauth's pleural massage, but no one can force me to place greater faith in it than in Oertel's heart massage.

CHAPTER XVIII.

DIGESTIVE ORGANS AND ABDOMEN.

If gymnastics are infinitely more important than massage in regard to the internal organs of the thorax, heart, and lungs, quite the opposite conditions obtain in the case of the digestive organs, with the exception of the liver.

In the first part of the book I have set forth the most important physiological effects of abdominal kneading. From these it is evident that this form of massage for anatomical reasons has widespread effects, which, however, are not yet fully understood. It influences the circulation as a whole, the secretion of digestive juices, the appetite, digestion and power of assimilation, peristalsis and the onward movement of the contents of the stomach and intestines, the metabolism of the digestive canal, and last, but not least, the nutritive condition of the musculature.

The effect of abdominal massage (= kneading) on chronic "atonic" constipation constitutes it one of our most important forms of massage.

Its effect on atony and on dilatation of the stomach is of secondary importance.

Massage may also be used to aid reabsorption of exudations within the abdomen, as elsewhere, and has often been used with good results both for *perityphlitic* and *peritoneal exudations*. I deal with this point later more in detail, and with the risks which often have to be considered in this, for the most part beneficial, treatment.

In many other abdominal diseases we are at present unable to estimate the value of abdominal massage, partly on account of our still defective knowledge of these diseases themselves, partly on account of our equally incomplete knowledge of the effect of mechanical stimulation on the activity of the nerves and glands. With regard to the effect of massage upon the different forms of dyspepsia and the various stomach neuroses, we shall do best to express ourselves with caution.

In this general survey of abdominal massage I remind my readers of the contra-indications referred to above. *In advanced pregnancy, large ovarian cysts and new growths in the abdomen, in hydro-nephrosis, in hæmorrhage from the walls of the urinary tract with stone in the kidney, in echinococcus in the liver or elsewhere in the abdomen, in acute inflammations and catarrhs, in strangulated*

*hernia, in ulcers in the alimentary canal, especially gastric ulcer, we do not use abdominal massage, neither should it be attempted in aneurysm of the abdominal aorta, and it is also out of the question where increase of blood pressure may cause danger.** In simple hernia, gall-stones, and in floating kidney or spleen it should be undertaken with careful attention to these conditions. Even with stone in the bladder, abdominal massage should be carefully administered and the region of the bladder avoided. I know a case in which an ignorant and daring masseur caused a violent hæmorrhage by abdominal kneading.

With regard to the technique of abdominal massage I refer to what has been said on pp. 35—38.

One can arrange the treatments almost at any time, but must avoid giving them too soon after meals; the best time is just before. The séances in obstinate cases should be given twice daily, and preferably for half an hour each time.

One ought previously to warn the patient that the abdominal wall will be tender after the first few days of massage, but that this will soon pass off.

The position of the patient during abdominal massage is important: the head raised, the knees flexed and somewhat abducted. He should breathe freely, and ought to control the contraction of the abdominal muscles, so easily produced by reflex action, which does away with the effect of the massage.

Abdominal massage in dilatation of the stomach and in ordinary chronic constipation may be undertaken by non-medical workers, if only they observe carefully the laws of technique. If there is a question of inflammatory residua in the abdomen, the massage should be performed by a doctor. The patient *cannot himself carry it out in the form described here.*†

* To what has been said on pp. 60—61 as to the effect of abdominal massage on the circulation I must add the following concerning Dr. T. Romano's observations (see "Effets dynamogéniques cardio-vasculaires du massage abdominale," Thèse: Paris, 1895):— During abdominal massage of a woman he noticed a contraction of the capillaries of the fingers, which was followed after massage was over by a considerable dilatation. In the frog he saw the vessels in the web of the back feet contract similarly, so that circulation almost stopped; after massage the opposite occurred. The effect upon the pulse was variable, but in seventy frogs he found the same as I have found in the human being—in ninety-three cases an acceleration of the heart-beat, in eleven cases negative or doubtful results. In some animals Romano found abdominal massage produce the same effect as the Goltz tapôtement on the abdomen—the heart standing still in diastole. In dogs, guinea-pigs, and rabbits abdominal massage often caused the heart to stand still in systole (" le cœur est réserré, tétanisé, presque arrêté "). Romano's and Colombo's researches seem to prove that gentle and short abdominal massage causes increase of pressure and slows the pulse, and that vigorous and continued abdominal massage causes diminished pressure and quickens the pulse.

† H. Sahli, of Berne, recommended letting the patient, in lying position, himself roll a cannon-ball of 3 to 5 lb. weight over his colon. In spite of the indignation such a course would awaken among those who attempt to surround the technique of massage with a nimbus of purely mystic difficulty, I agree with Dr. Sahli's statement that the effect of

Chronic constipation may have various causes, and it does not do to treat *all* cases by abdominal massage.

In those cases where constipation is caused by constriction of the alimentary canal, either by internal or external obstructions (tumours, stricture, hard fæcal concretions, pregnant uterus, peritoneal adhesions, etc.), we cannot, as long as these obstructions are present, expect any lasting benefit from abdominal massage.

If the diet is unsuitable this must first of all be altered.

In chronic poisoning (opium, lead, etc.) we must also in the first case look for the cause.

When the effects of nervous disturbances from the brain or spinal cord are making themselves felt in this way, we cannot expect relief from abdominal kneading.

But in the ordinary so-called atonic constipation, due to weak musculature and weak peristalsis, abdominal massage offers us the best and hitherto the only means of permanent relief without carrying with it any of the evil effects which to a greater or less extent are attached to all internal purgatives without exception.

If massage is performed correctly and for a sufficiently long period every day, eventual recovery is only a question of time, *i.e.*, months.

Even after appendicitis, where there is rigidity in a portion of the intestine on account of products of inflammation, massage, though not without danger in these cases, has usually excellent results.

Constipation commonly follows confinement, because the intestines tend to become distended by gases in order to fill the enlarged abdominal space, and so peristalsis becomes defective. Even these cases, which may be fairly obstinate, usually run a satisfactory course under treatment by abdominal massage.

For my part in a great many cases of chronic constipation which I have treated with massage, or handed on for others to treat, I have used no other means than simple dietetic instructions (hard bread or Graham's bread, raw or cooked fruit, etc.) and sufficient daily exercise. Special exercises to strengthen the abdominal muscles are unnecessary; chronic constipation is certainly only in very few cases caused by weakness in these.

Usually daily evacuation begins a few days after massage, often after the first treatment. In severe cases it may sometimes happen that daily evacuation begins first after weeks. In *all* cases one must previously inform the patient that the treatment, nevertheless, must be continued for some time, often two to three or sometimes four months, before the result becomes permanent, other-

this process in many cases is excellent. I do not know how this method arose, but heard of it as far back as 1884 from a patient who every morning rolled a smaller cannon-ball (covered with leather) round the abdomen, and who found it most effective.

wise the patient goes back gradually, more or less completely, to his former condition. In more severe cases massage should only stop when movement of the bowels has been uninterruptedly regular for a couple of months ; after that for some time one may allow the patient to be treated only every other day. The outlook is naturally better for thin patients with thin abdominal walls ; the treatment of obese patients is a thankless task, and it is well before one begins treatment by massage to submit them to a "reducing process."

When the constipation ceases, the patient's condition alters, as is well known, for the better, appetite is increased, dyspeptic symptoms lessen or disappear, flatulence, often so troublesome, is diminished, the whole nutrition is improved ; especially there is an improvement in the markedly lowered psychic condition so often present in severe cases.

Dilatation (and Atony) of the Stomach

in those cases where it is not connected with malignant growths and when no other contra-indications are found, should decidedly, in my opinion, be treated by massage, which at least frequently proves a valuable addition to other treatment. Whether the gastric dilatation is due to non-malignant stricture of the pylorus or duodenum, to slackness during or after severe general disease, to disturbed nervous influences, or to habitual overloading of the organ, massage assists the development and maintenance of the compensating muscular hypertrophy, which arises to a certain extent even in these cases ; also we must assume an effect on the altered secretion of gastric juice and the associated chronic catarrh.

There is no doubt that massage, in the earlier stages of the disease, is able to check its further development. It is also probable that in such cases, combined with other means, it is able to bring about a return of the organ to its normal size. I will not, however, put forward with certainty this claim for the effect of massage, as I am obliged to confess that, though I treated my first severe case of dilatation in 1878 *with excellent symptomatic progress, and later have treated many such cases, I have never been certain on this point.* In all cases when dilatation was established, minute examination with a sound at the close of the treatment, even when the conditions throughout were satisfactory, has shown that the volume of the stomach has remained unchanged. On the other hand, I have often seen massage at once cause a retrogression of the symptoms and a decided improve-*

* When we have an authority such as Kussmauls in favour of the possibility of a return to the normal limits without massage, even in marked cases, there is no reason to doubt that when this powerful means is introduced into the treatment a similar result can be attained.

ment in cases which before have remained practically unaltered, in spite of all other available means, although there was no appreciable alteration in the volume of the stomach.

The technique is as simple as possible, and consists of the small frictions mentioned above, which form part of abdominal kneading. These, in order strongly to stimulate the musculature, may be performed somewhat jerkily, so that the manipulation resembles tapôtement, though the masseur's fingers throughout remain continually in contact with the patient's skin. The treatment, which may be given by someone without medical or technical education, instructed in the manner of performing it, should be given at least once, preferably twice, daily. In more marked cases the massage must with short intervals be continued throughout the whole of the patient's life.

In treating dilatation one ought to include all really good methods. These are small, frequent meals consisting of the menu drawn up by Leube, containing the foodstuffs most easily digested (see below, in Weir-Mitchell's treatment), if necessary some aid to digestion such as hydrochloric acid and pepsin, faradisation of the stomach, stomach lavage (in Carlsbad by means of the mineral water) either (best) in the morning on getting up, or in the evening on going to bed, and finally an abdominal belt specially manufactured for the purpose ; these, together with massage, produce practically all that can be accomplished. But in advanced cases the patient can only be kept in a tolerably healthy condition by constant treatment by massage.

Chronic colitis with diarrhœa can also be treated by massage exactly similar to that which I have described with regard to chronic constipation. Similarly massage in these cases is best as an accessory to the other treatment. Of late years, however, I have employed the ordinary large, warm astringent washing out of the colon daily (*e.g.*, with 4 to 5 grains of tannin to 1 or $1\frac{1}{2}$ litres warm water), and after a few weeks have performed or ordered abdominal kneading over the accessible parts of the colon, and have not seldom seen unmistakable effects from it, especially in obstinate cases, where astringent washing out of the colon combined with treatment with tannigen internally (which often alone brings about recovery) has not been entirely satisfactory.*

Perityphlitic or Appendicitic Exudations

can be treated by massage like other exudations, of which they are a type, which arise in or near the abdomen after the inflammatory

* In many cases of chronic diarrhœa there is no better remedy than to eat daily a large quantity of dried bilberries. It is the slow progress through the entire alimentary canal of these undigested fruit-skins, rich in tannin, which is of value. In the case of an Anglo-Indian official, who had for a long time been under treatment by various physicians, this simple method had the desired effect.

process is over. It assists reabsorption and thus often relieves the constipation which is frequently present, removes the feeling of pressure or weight, or even of pain, due to the presence of inflammatory products, and diminishes also, by producing a complete reabsorption, the danger of repeated acute inflammatory processes.

The technique is also in these cases very simple. One presses into the abdominal wall with the upper phalanges of the three middle fingers over the exudation, and with infinitely gentle, even pressure performs the small manipulations, resembling frictions spoken of above, at the beginning for short, later for longer, periods, during which the patient takes the same position as for ordinary abdominal kneading.

In spite of the fact that massage lessens the danger of new inflammation by promoting complete absorption, this danger is undoubtedly increased during the actual treatment by the mechanical effect of massage. The shorter the time which has passed since the inflammatory process came to an end, the less completely has it entirely ceased, and the more tender to pressure the region attacked, so much the greater is the danger of producing relapse. The first rule of all in these cases, therefore, is to postpone massage treatment until some time (a few months) has passed since the perityphlitis, and even then only to perform it with the greatest possible care, and at the least warning, such as increased tenderness to pressure and spontaneous localised pains, to cease immediately. We must not forget that there is a perpetual risk which we cannot clearly estimate, since we never understand in detail the preceding process, its cause, and its connection with the vermiform appendix, the peritoneum, etc. All this is a riddle for us, since we have no other guide than palpation and subjective symptoms.

Finally, for many, apart from the old rule, excellent in practice, to avoid above all doing harm, and thus generally rather be passive than interfere, when such interference may easily be harmful, the consideration carries weight that if perityphlitis or appendicitis, which are particularly apt to recur, should do so whilst under massage treatment the patient and his friends will seldom fail to blame massage for the relapse.

From the above it is clear that in many cases it is immaterial whether the remains of exudation present after such processes are massaged or not. For my part, I have treated a number of cases in this way without any mishap, some with very good, some with tolerably good, results. The experience of my colleagues who in similar cases have had less success has, however, made me little inclined to take over these cases for massage until a considerable time has passed since the inflammation.

After extensive peritonitis peristalsis is often hindered by *adhesions*, and the patient is also troubled by severe pains on movement. Abdominal massage has in such cases often speedy and excellent results. The earlier it begins after the cessation of the peritonitis the more easily are the adhesions and newly-formed membranes absorbed or rendered thinner and easily stretched, but the greater the danger of producing new inflammatory processes. I dread much more, however, those cases which come to me after perityphlitis, or, to use a modern term, appendicitis, than after other peritoneal processes. If one waits a few months before beginning massage, and if, especially at the beginning of the treatment, one goes to work with careful friction with a small kneading movement, one can without danger produce results astonishing both to patient and doctor.

Chronic Gastric Catarrh

is treated by some doctors with massage, which has its enthusiastic advocates in this as in all other departments of medicine. But it is not going too far to say that, in the absence of reliable examination, we do not understand the effect massage by itself has on gastric catarrh. At the same time we may safely say that massage has never been the chief method of treatment, but so far has generally been replaced by dietetic means, mineral waters, washing out, etc., and only "specialists" ever think of treating simple gastritis by massage. On account of the constantly good results obtained from abdominal massage by a great number of patients with constipation, among whom a not inconsiderable number have also chronic gastric catarrh, and also on account of the undeniably good effects of massage upon sluggish chronic intestinal catarrh (so often underlying constipation) and other chronic catarrhs, we have reason to consider that massage may also be of great use in treating chronic gastric catarrh. As we can only reach a small part of the stomach of normal size its use must always be limited.

The same uncertainty applies to

True Dyspepsia.*

We do not yet possess (see p. 52) a satisfactory knowledge of the effect of mechanical stimulation upon the composition of gastric juice. It is reasonable to suppose that as the amount of gastric juice as a whole is certainly increased by mechanical stimulation, pepsin and hydrochloric acid, the constituents necessary for digestion, are also increased and their percentage possibly affected, and that this improvement, brought about by the active influence of mechanical stimulation on the cells of the glands, may perhaps be permanent; but at present Colombo's, Maria Serena's, and Romano's investigations into this cannot be definitely relied on.†

* By a true dyspepsia I mean a condition of disturbed digestion depending on anomalies in the composition of gastric juice.

† Investigations into this are more difficult to make on account of the numerous influences (bodily or mental) which may affect the composition of gastric juice, even under

On the other hand, there can be no doubt that the symptoms which arise in dyspepsia are lessened or disappear after abdominal massage; this surely everyone has experienced who has treated chronic constipation by this means, in which dyspeptic symptoms are also very common. Patients often confess that the feelings of pressure and weight, fulness or pain, which they experienced in the pit of the stomach after or apart from meals, are relieved, that flatulence ceases, the appetite is increased, etc., etc. One may state that there can be no question of massage when dyspepsia is combined with cancer or an unhealed gastric ulcer, but that it should be used when dyspepsia is combined with dilatation of the stomach. Apart from these diseases it may be tried, if desired, provided that there are no contra-indications, and it is not improbable that it may be of use in the former cases where there is diminished secretion of hydrochloric acid.

Nervous Diseases of the Stomach and Intestine.

To all who have occupied themselves at all with abdominal diseases, and especially with neuroses of this group, it is clear that at present it is not possible definitely to decide the effect of massage on these still very obscure forms of disease. All we know is that abdominal kneading in certain cases of sensory, and probably also of motor, disturbances has proved beneficial.

In the literature of this subject there are many statements as to the good effects of abdominal massage on *nervous dyspepsia*, the value of which is considerably lessened by the fact that this term is as yet indefinitely used. Personally I am inclined to believe that at present there is nothing which can throw full light upon the effect of massage *per se* on purely nervous dyspepsia. The dyspeptic symptoms by which people who suffer from habitual constipation are often troubled disappear when evacuation becomes normal, but these dyspepsias ought not, in my opinion, to be counted as purely nervous. Among patients who have undergone the Weir-Mitchell treatment with great benefit I have, however, seen the symptoms disappear of what is rightly called purely nervous dyspepsia, but the Weir-Mitchell treatment contains other important factors besides massage.*

Concerning massage treatment of the remaining abdominal neuroses, still so incompletely understood, we know very little.

The very painful condition which is often found in neurasthenics, and

exactly the same dietetic conditions, and on account of the impossibility of controlling what leaves the stomach at the pylorus, etc. In order to be of any value the examination must be continued a long time. One must examine the gastric juice for some time every day an hour after the usual test-meal (consisting of a cup of tea without sugar or milk and some wheaten bread) without massage, and examine again later under exactly the same conditions with the addition of massage, and it is not improbable that the latter analysis will show on the average a larger quantity of hydrochloric acid.

* The technique of massage in stomach neuroses is the ordinary "abdominal kneading" described above. As is well known, Burckardt found in nervous dyspepsia puncta dolorosa corresponding to the superior hypogastric plexus (which is found by pressing in in the middle line just below the umbilicus against the fourth and fifth lumbar vertebræ between the common iliac arteries). Pressure here causes pain, radiating from the solar plexus or pit of the stomach even up to the neck and head, to which Burckardt attributes a certain diagnostic meaning. Personally I have never troubled to massage over this point, but remind my readers of it because such an effect may possibly be of some value.

which by many doctors is summed up as *cramp of the stomach* (*spasmus ventriculi, spastic cardialgia*), often in my own experience quickly yields to frictions over the stomach. The same occurs with similar trouble in the intestine. Cases of flatulence especially are benefited, and the discomfort due to gases is diminished. The habitual vomiting of hysterical or otherwise nervous anæmic patients seems likewise to be benefited by abdominal massage.

Neither is it possible to give a satisfactory explanation of certain other allied disturbances. It is certainly true that such patients have been cured by abdominal massage. But who shall take upon himself to say to what influence the improvement was due? In many cases these abdominal neuroses are combined with general neuropathic or psychopathic conditions. It is difficult to estimate the importance of hypochondriac ideas which may be present; a certain amount of simulation comes into play,* and external psychical influences cannot entirely be excluded, etc. I have treated by abdominal massage with good results highly "*neurotic*" people handicapped by heredity, and have been successful both in cases of *anorexia* and *hyperexia*. It is, however, impossible to state the kind of influence which makes a patient eat after he has for some time taken it into his head that he cannot eat, or which causes someone to eat moderately who, as a result of some influence from the central nervous system, has for some time consumed daily enormous quantities of nourishment. Massage in these cases works in the same way as, for example, in the case of joint neuroses.

* * * * *

The liver, on account of its position immediately under the diaphragm covered by the lower part of the chest wall, is very little accessible to massage. But its circulation may be acted upon by means of active and passive movements, especially those movements which take place in the lumbar spine, trunk-rolling, side-bending, etc. By these the portal circulation is affected in two quite different ways. In all movements which lengthen the inferior vena cava its capacity is increased. When the vessel is again shortened by the opposite movement a part of its contents is emptied centripetally. Circulation in the vena cava is thus considerably quickened, and the same is also the case with the hepatic veins. The other way in which movements assist the portal circulation is due to the fact that the liver, chiefly in movements forward and sideways in the lumbar region and in trunk-rolling, is pressed together and the blood partially pressed out of it in a manner which may be aptly compared to the squeezing of a sponge after it has been filled with water.

It is obvious that suitable movements have a considerable influence upon the whole portal circulation, and they form also a

* And between the strongest hypochondriac imaginations and the purest simulation there is every possible transition stage.

very important part of the "bedroom gymnasties" which many people take on getting up and going to bed, especially those leading sedentary lives, who have themselves often noted a markedly beneficial result on the functions of the liver, especially on the secretion of bile, which is easily observed.

Direct massage of the liver has been little used, and it is doubtful whether it has any great future before it. The chief clinical literary work on this subject has been brought out by Dr. Gustave de Frumerie.*

He has massaged the liver over the small part of it accessible under the costal margin, with *effleurage* in the form of strokings from left to right and from right to left. A sort of *pétrissage*, which Frumerie calls "écrasement," is performed with the last phalanges of the left hand against the right lobe, and with the last phalanges of the right hand against the left lobe under the border of the ribs, by means of which the hands, especially in deep inspiration, move towards each other. Another kind of *pétrissage*, which is only possible with lax, thin abdominal walls, is performed by the masseur with four fingers, the hand, well supinated, pressing into the abdominal wall as far as possible against the *under* surface of the liver, the thumbs resting against the border of the liver immediately under the costal margin, while the patient lies in bed with head bent forward and legs flexed and abducted. *Pétrissage* is then performed by pressing in towards the under surface of the liver, but only in few cases can it be done in this way. Pressure may be similarly applied to the gall-bladder with the fingers immediately outside the external border of the right rectus abdominis where it meets the margin of the ribs. When this is possible *pétrissage* is performed with the patient sitting in forward-leaning position (with abducted legs). In this position one can also perform *vibrations* on the liver.

Frumerie uses all manipulations in the order thay have now been described, or similar ones, in *hypertrophy of the liver*, *in cirrhosis of liver*, especially in the (very rare) hypertrophic form ; in some *forms of diabetes*, when the formation of sugar may be supposed to arise, not by increased activity of the liver cells, that is to say by increased metabolism, but by diminished activity of the cells so that they do not store enough sugar as glycogen but allow too much of it to pass into the hepatic veins † ; in *gout*, which is thought by many to be due to disturbances of the liver ; in *catarrhal jaundice after the acute stage*, and in diminished functional activity of the liver ; in *cholelithiasis after the crisis*.

Frumerie gives cancer, abscesses or tumours in the liver, fatty and amyloid degeneration, as contra-indications to liver massage.

With lack of experience I have no right to deny the value of liver massage, and I acknowledge most willingly Dr. Frumerie's service in testing it and discussing its uses.

Personally I have so little faith in the therapeutic value of liver massage that, in spite of having treated in Carlsbad every year a considerable

* "Le Massage direct du foie et des voies biliaires," by Dr. Gustave de Frumerie : Paris, 1901.

† This probably occurs in the so-called alimentary glycosuria with small secretion of sugar an hour after a meal, which form may be called, with Gilbert, *diabète par anhépatie*.

number of cases of this kind, I have no desire to use it in hypertrophic cirrhosis, in which it might be supposed to be of most value.

The *Spleen* may be affected by movements in the lumbar region, by means of which part of its blood is pressed out. Whether any attempt has been made to affect it by massage, which one might suppose to be of use in the enlargement of the organ after malaria, I do not know.

CHAPTER XIX.

URO-GENITAL APPARATUS.

A. The Female Sex Organs.*

Gynæcological massage, so much used over the greater part of Europe, and partly even in North America, was originally introduced by the well-known Major Thure Brandt,† who died in Stockholm towards the end of the nineteenth century. Between the years 1880—1890 it became so generally known and so well established that it cannot be ignored by any doctor.

In gynæcological massage, which forms only a part of the manual treatment of the diseases of the female genital organs, frictions are chiefly used, in the majority of cases to remove the remains of inflammatory processes, sometimes to work upon inflammation of a torpid nature or to remove extravasation of blood.

Since the treatment for these conditions is practically the same for all, one description will suffice, and any necessary remarks will be added later in connection with the disease treated. Brandt's treatment of prolapse of the uterus is described by itself.

During the treatment the patient lies with the head raised, and

* This chapter, which is little different from what I wrote in my first book on Massage, has been inserted as a result of the limited experience I have gained by watching Brandt's massage and by treating several cases of exudation in the female pelvis which I have come across in my own practice.

† Certain forms of gynæcological massage were used, particularly by French doctors, before Brandt; but the honour of being the first who, by his independent energetic work compelled medical men to adopt this treatment and to give it a place in therapeutics must be assigned to Brandt. His very reliable gynæcological work dates from 1861. His scanty theoretical training and his assured way of expressing his at times fanciful opinions, his writings, which are full of the faults common among gymnasts, as well as his piety, all combined to set the medical profession against him. Brandt, in his mechano-therapeutic turn of mind and his technical skill, had much talent; those who consider that genius consists in reaching a high pitch of excellence in one particular direction will attribute even genius to him. Early in the seventies Dr. Sven Sköldberg made a complete study of "Brandt's method." The treatment thus found its way to Scandinavian doctors and gynæcologists. Netzel and Sahlin in Stockholm, Asp in Helsingfors, Howitz and Örum in Copenhagen, all took up massage, also Nissen in Christiania. On the Continent Bunge was the first who wrote anything of value (1882). Gynæcologists of authority—Bandl, Hegar, Martin, Schroeder and others—recognised and introduced far and wide the use of gynæcological massage, while a considerable number of German doctors obtained from Brandt himself a knowledge of his method. In America Reeves Jackson did good work in the same subject. A definite step towards permanently fixing the position of this treatment was made in November, 1886, when Brandt, on the advice of Dr. Profanter, who had seen his work in Stockholm, went to Jena, and under the control of Professor Schultze himself treated many cases exclusively by his method, cases afterwards examined by Profanter. Just before 1890 Brandt's method was described by several doctors (Seyffart, van Braun-Fernwald, Kleen and others), and in a few years became generally known.

if possible also with the pelvis slightly raised, upon a plinth, with knees flexed and abducted and with the feet resting with the whole sole upon the plinth. This position (which resembles the lithotomy position) aims, among other things, at relaxing the abdominal wall. The masseuse sits on the patient's left side near the pelvis and slightly turned towards her, so that, passing the left hand under the thigh, she can insert the forefinger into the vagina right up to the posterior fornix, and thus raise and support the uterus and the adnexa, particularly those parts which are to be massaged,* pressing them towards the right hand, which is performing massage over the uterus through the abdominal wall. The left hand is kept open, the three middle fingers against the perineum, the thumb at a slight distance from the symphysis pubis, and the forefinger (apart from the slight movements necessary to raise one after another the various parts against the abdominal wall) immovable in the vagina against one of the side walls or the posterior wall, never against the front wall. With the three middle fingers of the right hand pressed close together she presses the relaxed abdominal wall over that part which is to be massaged and proceeds according to the usual rules, of which we shall only repeat here that small circular frictions must be begun nearest the centre (in regard to the circulation), always with moderate strength, similar to those described in abdominal kneading; for this the masseuse may support her left elbow against the plinth. The movement necessary for the manipulations performed by the right hand takes place chiefly in the shoulder joint. This is the only useful manipulation in those cases in which the object is exclusively to remove exudations or infiltrations.†

In the numerous cases in which, besides the products of inflam-

* In this way gynæcological examination is very easily carried out, and those who are accustomed to this method often prefer it to the usual way. The masseuse's right hand (the one working) ought to be kept closely upon the skin under the chemise. But no part of the patient's body need be exposed, and Brandt's method is less disturbing to the patient than the usual bimanual examination. When there is a question of local applications, operative manipulation, etc., the usual position of the doctor sitting between the patient's legs is of course a necessity.

† After inserting the left index finger into the vagina and placing the right hand as described above, Brandt begins the treatment by means of strokings performed over the lymphatic vessels of the part in order to quicken the circulation and empty the vessels, a difficult task in view of their unfavourable anatomical position.

Brandt makes a point of using only one finger, the index finger, in the vagina under all conditions. Many doctors who have interested themselves in this form of massage often insert both the index and middle fingers into the vagina. I myself found at the beginning that this was better and less of a strain, but accustomed myself later to the use of only one finger.

At the end of the treatment Brandt tells the patient to raise the lower part of the back and pelvis actively from the plinth, so that she rests only on the back of the neck, upper part of the back, and the feet, and then makes her perform in this position abduction and adduction of the thighs, with resistance at the knees, several times. The abduction is said to deplete the pelvis. (Resisted abduction he uses to strengthen the floor of the pelvis, so that this is specially suitable in prolapse, to which subject we shall return later.)

mation, one has to deal with a displacement or limitation in the mobility of the uterus, massage ought always to be accompanied by other manipulations, which have for a long time been used in gynæcology to stretch contracted or shrunken parts, to which subject I shall return later.

With younger persons and virgins the support is made by the index finger in the rectum instead of in the vagina.

The length of treatment in gynæcological cases varies very much according to the nature of the case; the average is fifteen minutes.

The patient must empty the bladder immediately before treatment; if the manipulations are to take place through the rectum, this also should be empty.

For *contra-indications* to massage of the uterus I refer the reader to pp. 65—68. I will only repeat here that *pregnancy* in every stage is to be considered a contra-indication, and similarly all acute, particularly all *purulent inflammation* (*e.g.*, *gonorrhœa*). The effect of massage of the uterus upon the nervous system not infrequently prohibits its continued use. Further, of course it is obvious that massage should not be done during *menstruation*, though Brandt did so, partly on account of the discomfort to the patient and masseuse, partly because it certainly increases the hæmorrhage. Finally, it may be necessary to remark that *the uterus must only be massaged in cases where there are symptoms of pelvic trouble.* The remains of inflammation, displacement, etc., which, as is often the case, do not produce special symptoms, should be left alone.

Gynæcological massage, with very few exceptions, is the work of the medical practitioner. It requires long experience and the highest proficiency in palpation and diagnosis, together with sufficient knowledge of the normal and pathological anatomy of the parts, and it requires to a greater extent than any other form of massage the recognition of all the possible dangers, which is only possible with wide medical experience.

Exudations and Infiltrations in the Pelvis.

Among the diseases of women which lend themselves best to massage * are the *parametritic and perimetritic exudations* and

* In this chapter, as in the rest of the work, I have omitted certain uses of massage which I consider unjustifiable. For instance, I have entirely omitted massage of fibroids, without speaking either of their diminution in volume or of the lessening of the hæmorrhage which follows, which some people profess to have observed. Similarly I consider that there can be no reason whatever for giving massage to ovarian cysts of any kind or under any conditions. Finally, I think it is unsuitable in amenorrhœa to attempt *directly* to produce menstruation in anæmic patients by means of mechanical stimulation. These patients are not anæmic because of the cessation of menstruation, but on the contrary, menstruation and ovulation have ceased on account of the anæmia, and it must be considered as nature's attempt at economic compensation.

the inflammatory products, more or less remote from the original disease, which affect the pelvic organs, its connective tissue, or its serous membranes (*e.g., oöphoritis, perioöphoritis, salpingitis, perisalpingitis, pelvic cellulitis*, etc.) after the inflammation has subsided. In these days a considerable number of gynæcologists are in a position to compare the results of their treatment of these cases without massage with the results they have gained later with the use of massage. Among these the opinions on this important point are unanimous. *The products of inflammation are more quickly and completely removed by massage than by any other treatment, and for the most part the danger of a relapse is also removed; the uterus regains its mobility to a greater or lesser extent by the stretching of shrunken tissues, bands or adhesions, which is often of great importance in removing the symptoms.* As regards the consequent alterations in the position of the uterus, to which I shall presently return, one must confess that *complete replacement, especially in cases of retroflexion and fixation, is an exception;* on the other hand, one may claim that the improvement is usually sufficient to remove the troublesome symptoms and that the alteration in position is usually of little consequence in itself when the organ is no longer fixed.

The shorter the time which has elapsed since the inflammation was acute the greater the danger of producing fresh inflammation, and this forbids us to advocate early treatment, in spite of the greater ease with which recent exudations are removed by massage than those of longer standing. When one remembers how products of inflammation which have been present for many years may be almost entirely removed, one must not place too much importance on the conditions which may arise through allowing one or two weeks more than are necessary to elapse before beginning massage treatment. The suitable time for this varies in different cases very much, but a minimum time may be given, which ought to separate the last of the symptoms of acute inflammation (marked tenderness to pressure, rise of temperature, etc.) from the first massage treatment; for my part I consider two months is not too long for such a minimum length of time. Besides the long time which has elapsed, the characteristics which distinguish the older and less dangerous exudations and may to some extent serve as a guide to us, are the firmer consistency, and lessened tenderness to pressure. When the treatment begins during the earlier days of exudation, one must, especially at first, go to work with the greatest care, and at the least sign of any irritation producing acute inflammation one must stop massage at once.*

* In this connection I would emphasise the necessity of letting a long time elapse between similar acute inflammatory processes and treatment by massage of the consequent

In *perioöphoritis* and *oöphoritis* (between which we cannot distinguish in practice, and which we therefore class together here) massage is often used with advantage, and is carried out, mutatis mutandis, in the same way as in perimetritis or parametritis. In these cases also the exudations are removed more quickly than by any other means, and with the exudations the pains are removed; one may later possibly stretch the adhesions present and restore the ovaries to their former position. Here, however, as in the case of the uterus, the chief object is not to replace the organ in its absolutely normal position, but to restore its mobility. This may be done either from the vagina or from the rectum; one may try carefully to insert the tip of the finger between the adherent organ and the part to which it is fixed, and equally carefully and by degrees to stretch the adhesions, helping this by means of the other hand placed outside the abdominal wall. The technique in these cases is often difficult. Too strong manipulations are dangerous. Enlarged ovaries, in spite of massage, often remain undiminished, a fact which is of no clinical importance.

In a work of this kind it is as important to point out the dangers of massage of diseased ovaries as to state the indications for massage treatment of those diseases which massage can cure. To begin with, the diagnosis often requires a skill in palpation which can only rarely be found among "general practitioners." And there are still fewer among us capable of recognising changes in the tubes which would make massage in their neighbourhood dangerous.

As regards inflammatory processes and the conditions in the tubes resulting from them, it is my opinion that in the great majority of cases they should only be treated by massage with the very greatest care even by doctors. I will not deny that various inflammatory changes in these regions *can* with advantage be treated by massage, or that this has been done in many cases. But I wish to differentiate between those cases in which this can be done without danger and those in which there is more danger than advantage in massage, and which present great difficulties even to an experienced gynæcologist. If a purely serous salpingitic exudation empties itself into the pelvis through the distal orifice of the Fallopian tube no danger usually follows. One of the rather common cyst-like dilatations of the tube may often burst without dangerous symptoms arising. But if a purulent exudation, however slight, with the

inflammatory products. To speak of massage for the phlegmon of the thigh, which is called *phlegmasia alba dolens*, resulting from phlebitis and lymphangitis, is pure foolishness. As long as such a condition continues it forms the strongest contra-indication to massage, which may only be thought of many months after recovery, in order to remove the infiltrations which remain.

power to set up inflammation makes its way through the peritoneum, there is grave danger of peritonitis. There are cases which have come to my knowledge among the unwritten records of gynæcologists which demonstrate this danger.

Shortly before I gave my definite opinion that these cases were in every respect unsuitable for treatment by massage except by a gynæcologist, a German colleague sent me for treatment a young woman in whom might be clearly felt through the abdominal wall an enormous salpingitic and perisalpingitic exudation, which for many months did not show the slightest tendency to reabsorb, the result of gonorrhœal infection from her husband. I began treatment exclusively through the abdominal wall with small careful manipulations, such as I have described in this book as "abdominal kneading," and after only two weeks reabsorption began. After most of this obstinate exudation had been absorbed, I dispersed the greater part of what remained by bimanual treatment, ending the treatment with a feeling of relief from a great responsibility.

Salpingitic processes will certainly in the future be dealt with more by surgical methods than by massage, although a specialist accustomed to this routine may often remove by means of massage very troublesome thickenings, swellings, and the resultant pain and tenderness in and round the tubes.

Koblanok does not massage directly upon pyosalpingitic exudations, but upon the uterus, which may be said to work as a suction pump by means of the changes of form and thus suck out the exudation "per vias naturales." Personally I know nothing of the value of this treatment.

Massage is of no use whatever for displacements caused by tumours in or around the uterus. For congenital conditions of a similar kind, as for those which arise as a result of laxity in the adnexa, the value of massage in any case is very much more limited than in cases of exudation. At present it cannot be definitely estimated. We may leave it an open question whether the inflammatory residua are, as many are inclined to believe (Ziegenspeck, Freund, and others), almost exclusively the cause of forward deviations owing to retraction of the sacro-uterine ligament, or of backward deviations owing to retraction of the connective tissue between the cervix and the bladder, or of lateral deviations owing to retraction of parts within the broad ligaments. What is certain is that the presence of such residua very often causes alteration in position and fixation of the uterus, and that it is in these cases that one may expect the best results from manual treatment.

Much more important than the correction of displacement is the restoration of the normal mobility of the uterus. To attain this end

it is obvious that the products of inflammation must be removed by means of frictions, and that the shortened and shrunken parts must be lengthened by lifting, pushing, stretching in various ways, and replacement. The manipulations, which are in themselves not necessarily massage manipulations, are carried out in the usual gynæcological manner, usually bimanually, by working on the uterus in two ways, through the vagina and through the rectum or the abdominal wall.* The patient, according to the nature of the case and the difficulty in treating, ought either to take up the usual position on the back, or to remain standing, or to take up the knee-elbow position on the plinth. If the uterus is fixed one tries little by little to loosen it by means of moving it with gentle force in the opposite direction. I would specially draw attention, however, to the fact that the "liftings," so well described by Brandt further on and used for prolapse, may with advantage be used for other misplacements, especially for deviations backwards, to stretch the contracted parts. *All manipulations which aim at stretching the parts shrunken as a result of inflammation belong particularly to the later part of the treatment, after frictions have done their work; to stretch parts which are still largely infiltrated or contain a considerable amount of exudation cannot produce satisfactory results.* Further, it is necessary to emphasise that *all stretchings must be made softly and gently*, and that one must content oneself with gradually rectifying the position without using undue force. It seems to me to be sufficient to refer to the above manipulations, which do not belong to massage, without further complicating matters, in order to give the reader an idea of the endless variety of manipulation according to the nature of each case. They are not in themselves specially difficult cases when the details are once understood, but this for any one not a specialist is often difficult enough.†

With displacements, however, when it is not possible to obtain complete replacement, the question arises of treatment by means of pessaries

* Brandt, who was most dexterous, could however often replace a movable uterus which had slipped backwards with one hand, by means of inserting the forefinger in the vagina and carrying the fundus upwards and forwards, and then quickly pushing the cervix backwards and upwards, though others were obliged to use both hands. He did this with the patient in standing position. In other cases of retroflexion, very difficult to replace, he, like other gynæcologists, was obliged to work upon the uterus in all three ways by inserting the thumb of the left hand into the vagina and carrying the cervix backwards, with the forefinger of the same hand in the rectum drawing the fundus forwards, the manipulation being assisted by the right hand on the abdominal wall. From witnessing Brandt's work one obtained the impression that he developed also this part of the treatment much more than most gynæcologists, as a result of constant use of the manipulations and also of using them in different ways.

† Gynæcological massage is perhaps that which requires the greatest skill, but even in this the technique of massage is so easy compared with the diagnosis that an otherwise well-trained gynæcologist can easily learn it in one day.

or other supports along with or after massage. I would here remind my readers of the modern opinion that the displacement is in itself unimportant, and that the use of the pessary has largely decreased.

The products of inflammation are, along with massage, treated by the usual absorbent means, tampons supplied with various medicaments, mud baths, compresses, hot irrigations, which latter I constantly use with some kind of iodine tincture.

* * * * *

Extravasations in the true pelvis respond to massage in the same way as exudations, and massage is now constantly used for *retro-uterine hæmatocele*, and in the treatment of extravasations the same rules apply on the whole as for exudations. It is important that the massage should not be begun too early. One should wait several weeks in order to avoid giving rise to fresh hæmorrhage.

* * * * *

Chronic metritis, which is rare as a primary disease without complications, has been treated by many doctors by massage, and a considerable amount of information is contained in the literature of the subject (chiefly in the writings of Asp, Brandt, Reeves-Jackson, and Prochownik). If one examines their writings critically and at the same time listens to the Swedish gynæcologists who are specially experienced in such cases, one comes to the following conclusion :—*massage for chronic metritis gives results which may be considered tolerably satisfactory compared with other treatment, especially with regard to the extreme obstinacy of the products of inflammation.*

The very marked discomfort in the form of pains and dragging sensations of chronic metritis is speedily relieved ; similarly, the dysmenorrhœa diminishes or ceases, as well as the symptoms from the bladder and rectum, and the hæmorrhages. In quite a number of cases after treatment has continued some time it has been possible to feel both by palpation and with the sound a shrinking of the swollen uterus and a return to the normal volume and consistency. (Brandt himself stated, on the other hand, that he had scarcely ever been able to restore normal consistency to a *hardened* uterus.) The sterility which so often accompanies metritis is removed, and women who for many years of married life have not yet conceived, or who have had miscarriages, are after treatment often able to bear children quite normally. The displacements which often accompany chronic metritis have a very bad prognosis.

Chronic endometritis, which usually accompanies chronic metritis, also responds to massage (alone ?), and the mucous membrane returns to the normal even when " fungoid " changes are present. Profanter adds to his account of a case of chronic metritis of

Brandt's treated by Schultze, where retroflexion and prolapse as well as severe endometritis were present, the observation that before beginning to massage in chronic metritis, the accompanying chronic endometritis must first be removed by the usual treatment. *There are, however, many statements, some certainly reliable, to the effect that massage has a healing effect on chronic endometritis, which is very probable, considering its effect upon chronic catarrhs of other mucous membrane.* There is no objection to using various local (or general) means along with massage. Statistical information given by Prochownik shows that the simple forms of endometritis give also fairly good results with massage treatment.

Among cases of chronic metritis are included *incomplete involution* ("*sub-involution*") of the uterus after childbirth. Although I may say that even these have been treated advantageously with massage by many people, I must not omit to add at the same time an opinion of Prochownik which seems to me hard to confute.* He also acknowledges the good and fairly speedy results of massage in these diseases. But as he has obtained equally good results with other treatment (washing out of the vagina with gradually increasing pressure and warmth, hip baths, glycerine tampons, iron, quinine, hydrastis canadensis and subcutaneous injections of ergot) he considers that he has good reason for entirely giving up the treatment of sub-involution by massage, which is a troublesome and unpleasant treatment for every one, and which may have harmful effect on a nursing mother. It seems to me clear that in these cases massage should be avoided, unless other treatment proves unsatisfactory.

The technique of the treatment for chronic metritis is similar to that described above, viz., bimanual, with the index finger of the left hand in the vagina as support for the uterus and the fingers of the right hand used to massage through the abdominal wall. The length of treatment required is, on an average, two to three months.

It is, however, important, especially in chronic metritis, to remember to remove any possible cause, especially the not uncommon abnormal sexual irritation of various kinds.

Along with massage it is an excellent plan to use the various hydrotherapeutic means and those which regulate the action of the bowels, etc., common mineral waters, general hygiene, gymnastics, and other means.

* Norström also, whose optimistic tendency is well known in Sweden, confesses that the position of the uterus as a rule after his massage treatment was, or soon became, the same as before, while the chronic metritis and its symptoms definitely disappeared, and he considers this fact a proof of the unimportance of deviations in the position of the uterus.

Prolapse of the Uterus and Vagina.

In order correctly to understand Brandt's treatment of prolapse of the uterus, in which the actual massage manipulations are less important than the other manipulations and a particular kind of local gymnastics, it is advisable to recall the anatomical conditions and the numerous changes which (more or less important in each separate case) may underlie the abnormal condition in question.

As an introduction we must remember that sinking or forward-falling of the vagina and uterus is found mostly in child-bearing women, especially after numerous confinements, and often after extensive tearing; and that increased weight of the uterus owing to metritis or subinvolution or fibroids, also laxness of the surrounding parts either due to sudden emaciation or to conditions of degeneration after severe diseases or during senility, form predisposing causes. A less usual cause may be increased abdominal pressure in forcible effort or strain generally, or in defæcation. The position of the uterus in relation to the vagina is also to be considered, in that an increase or diminution of the normal angle between the two apparently increases the possibility of prolapse, especially if such a position (which may occasionally arise merely as a result of a distended bladder) becomes permanent for any reason. Finally, we would remark that in many cases of prolapse the sinking of the vagina is primary, and causes lengthening of the cervix and finally prolapse.

In order to obtain a correct idea of these cases we must not persist too much in the narrow idea of the uterus as an organ suspended in its position by folds of peritoneum, by the sacro-uterine and pubo-vesico-uterine ligaments, as well as by the broad ligaments and round ligaments (but especially by the first two). One glance into the female pelvis will show us that these adnexa even in a virgin, and to a still greater extent in multiparæ, allow some sinking of the uterus, although much cannot take place without a stretching particularly of the sacro-uterine and pubo-vesico-uterine ligaments. Besides this suspension apparatus, the position of the uterus depends also upon a supporting apparatus, and it is in the conditions mentioned above which cause changes in these supports and their muscles, especially in levator ani, that we find the most important causes of prolapse. For details as to the structures forming the floor of the pelvis I refer the reader to the anatomical text-books and diagrams, and especially to the dissecting room, and will only draw attention to the fact that the middle fibres of the funnel-shaped levator ani, running in a sagittal direction covered both above and below with fascia, surround the rectum and vagina on both sides, that the muscle gives fibres to the space between the two which is filled with connective tissue, and in this manner surrounds the vagina on three sides in its under part, and assists in fixing its position and under certain conditions contracts it. According to Ziegenspeck it takes part also, especially when the uterus has not a retroverted or retroflexed position, in preventing prolapse, by drawing the upper part of the vagina forward and slightly upward, so that it becomes more horizontal and consequently gives a better support to the cervix. At a somewhat lower level than levator ani, towards the front of the pelvic outlet, and covered on its upper surface with a layer of pelvic fascia and on its under surface with the perineal

fascia, we have the deep transversus perinei muscle (Henle), or the urethro-genital diaphragm (Henle), which allows a passage for the urethra and vagina, and has a great influence on the position of the vagina and its ability to resist a force distending it. Finally, for the fixation of the vagina we must remember the whole of the perivaginal connective tissue, especially that portion of the figure-of-8-shaped collection of muscle-fibres whose posterior portion is formed by the external sphincter ani, and whose anterior portion is known as sphincter vaginæ.

With the above facts in view we may pass on to a description of *Brandt's method with all its details in the treatment of prolapse.* He introduces the treatment by giving a gentle tapôtement (with flat hand or closed fist) over the sacral region, while the patient stands bent slightly forward with the arms stretched forward and hands supported against a wall or boom; this aims at producing a stimulation in the corresponding nerve centres. Then the patient lies upon a plinth in the position described above, with the head raised, pelvis lifted, legs flexed and abducted, and with the feet together. The doctor sits as above described on the patient's left side. The prolapsed uterus is now replaced in the ordinary way, along with the possibly accompanying cystocele or proctocele, as far as possible into the normal anteflexed position; if this cannot be done, it is then replaced by the mechanical manipulations already described in this chapter, a task which may sometimes delay further treatment. When the uterus is fully replaced, Brandt's so-called "double treatment with lifting" is performed, *i.e.*, a process which requires an assistant. The assistant * kneels upon the plinth between the patient's knees and lifts the uterus and its adnexa from the outside in the following way:—leaning over the patient with hands fully supinated and ulnar borders in contact, she inserts the three middle fingers between the uterus and the pubic bone, exerting a fairly forcible pressure upon the abdominal wall; with her hands gliding over the abdominal wall she then grasps the uterus and draws it in the direction of the abdominal cavity † as far as it will go without causing undue pain or using too much force (*i.e.*, it is brought much higher up than its ordinary position). At the same time the doctor's left index finger follows the vaginal portion of the cervix in its movements as far as possible, and carries this backwards; when the lifting carries the cervix out of reach the finger is kept as high up as possible in the vagina to grasp it again as it descends and push it backward. This "double treatment" is repeated three or four times; during every drawing-up the normal anteflexed position of the uterus is controlled in the above manner. (As already said, a retroflexed or retroverted uterus is never lifted.) When these liftings have been performed the so-called double treatment and the need for an assistant is over. The doctor, who continues to sit in the same position, performs small kneadings with the three middle fingers of the right hand, pressing through the abdominal wall, with the object of stimulating the hypogastric plexus on both sides and the posterior part of the sacro-uterine ligament. If

* For this Brandt always employed a woman "gymnast."

† There is no need of a lubricant to facilitate the gliding of the hands over the abdominal wall.

the uterus is swollen or there are remains of inflammation present an ordinary kneading is performed. Later the doctor performs gentle nerve frictions with the right hand towards the left hand, which acts as a support outside the labia majora, in order to stimulate the inferior pudendal nerves if there is any prolapse of the vagina. Similarly the wall of the vagina, if lax, is pushed up and worked upon with small, limited, but tolerably firm frictions, while it is pressed against the posterior surface of the pubis. When this is complete the patient actively raises the lower part of the back and the pelvis from the plinth, so that she rests with only the neck and upper part of the back and feet upon the couch; in this position she performs a few *eccentric abductions and concentric adductions, the patient holding the knees together while the doctor parts them against the resistance of the patient, the patient then closing her knees against the resistance of the doctor. This aims at strengthening levator ani (see below). After several repetitions of this movement the doctor again inserts the index finger of the left hand into the vagina, draws the cervix backwards if it is not already drawn back, and, continuing to fix it in this position, assists the patient with his right hand to raise herself from the plinth, and does not remove his finger until she is standing, so that he has all this time controlled and fixed the position of the uterus, which otherwise may easily fall suddenly back as the patient raises herself. Finally the treatment ends in the same way as it began, *i.e.*, with gentle tapôtement over the sacral region. Often the patient may, with advantage, lie for an hour face downwards on a sofa.

There still remains, however, a not unimportant part of the treatment. The patient must be instructed on getting up in the morning and after going to bed, as well as several times during the day, to exercise the muscles of the pelvic floor directly, by means of taking the position described above and vigorously closing the knees so as to bring into action levator ani and the external sphincter (in the same way as when a straining effort is made to prevent the expulsion of wind or fæces from the rectum).

Besides mechanical treatment Brandt used no other method except douching the vagina with water at the ordinary temperature of the room, which the patient herself may carry out. Hydrotherapeutic and electrical treatment may, however, be used with advantage.

If we review quickly Brandt's method of treatment we shall find that in every detail, more or less effective, it corresponds to the points of definite therapeutic treatment of prolapse on a pathological anatomical basis. A good many of the manipulations are certainly of slight or indefinite value. In particular it would be as absurd to lay great stress upon sacral beating or nerve frictions upon the hypogastric plexus and sacro-uterine ligament as it would be to deny their use altogether; only in very few cases with particularly slack abdominal wall are they likely to attain their object. The nerve frictions along the course of the inferior pudendal nerves may certainly be omitted without affecting the result. The chief part of the treatment besides reposition, the obvious result of which I may pass over, are the liftings. These aim at opposing all the

* Translator's Note.—This movement is described in Chap. IX., according to the muscle work and not the form of the movement as adduction, concentric and eccentric.

mechanical conditions present in prolapse. It is doubtful whether the liftings always or often fulfil Brandt's object in stimulating the adnexa, which contain muscle fibres, to contraction through sudden stretching, particularly of the sacro-uterine ligament, as the indirect attachment of the uterus to the floor of the pelvis prevents extreme lifting much more than the said adnexa. On the other hand, quite a small amount of lifting of the uterus above the normal level results in a stretching of inflammatory adhesions, which are so often the cause of alterations in position and of fixation, particularly backward, and which, without stretching, allow very little lifting of the uterus (Ziegenspeck). The liftings thus help to restore mobility to the uterus. The resistance exercises performed by the adductors, as explained above, aim, according to Brandt, at strengthening the muscles of the pelvic floor, especially levator ani, which is important as a support both for the uterus and the vagina; others also have recognised their importance in this respect. Neither can it be denied that the pelvic muscles, which, from what we have said above, contribute to maintain the normal position of the genital apparatus, to a certain extent take part in exercises for the adductors, especially when the patient takes up the position described, supported only by the shoulders and the soles of the feet. Examination, however, easily shows that, owing to the effect of levator ani on the position of the anus, (1) this muscle and in all probability also the other muscles of the floor of the pelvis are brought into action very slightly and scarcely noticeably in vigorous resisted adduction of the thigh; and (2), on the contrary, levator ani acts much more strongly in strong innervation of the external sphincter muscle, as in holding back the contents of the rectum. For my part I consider, therefore, the useful part of Brandt's gymnastic treatment for prolapse, the exercise in which the patient, as above described, uses the muscles of the pelvic floor, and that these are infinitely more important than resisted adduction, which scarcely strengthens any other muscles than the adductors themselves. Liftings and contraction of the muscles of the pelvic floor are therefore the most important part. Exercises for the adductors and treatment of the wall of the vagina are certainly far less important; the other parts of which the treatment consists are of very little consequence.

The value of uterine massage for chronic metritis in lessening the weight of the uterus is clear.

It is obvious that Brandt's method of treating prolapse is of more interest than of practical importance, that it can replace operative methods only to a small extent, and that most patients prefer to submit to the simple operation for prolapse with excision of the cervix, kolporraphy and perineorraphy, which produces the desired effect in a short time, and at least in the majority of cases permanently removes the trouble, than go through Brandt's treatment, which usually lasts several months and is much less certain. We must, however, acknowledge that prolapses which have lasted ten years have been really cured by Brandt, and it ought to be remembered that it may be used as a suitable preparation for operation, and that especially the gymnastic part may also be good treatment after operation.

Von Braun-Fernwald and Kreis consider that the following cases of prolapse should be operated upon :—

(*a*) Those which are combined with severe muscle atrophy;

(*b*) Those arising in emaciated, decrepit, or senile individuals ;
(*c*) Those which are not improved by three weeks of Brandt's treatment ;
(*d*) Those combined with perineal deficiency ;
(*e*) Those combined with considerable hypertrophy of the cervix.

They consider, further, that pregnancy, tumours, fixation of the uterus, and inflammatory processes contra-indicate Brandt's method, which ought scarcely to be considered where there is great development of fat in the abdomen, or very tense abdominal muscles, on account of the difficulty of performing liftings in these cases.

In obstetrics, manipulations are used which may be considered as massage, for *defective post-partum contraction of the uterus*, and the consequent *hæmorrhage from the placental site*, in which cases, as is universally known, the organ is treated by moderately firm frictions through the abdominal wall, and in this way is stimulated to contraction.

B. The Urethra, Bladder, Testicles, and Prostate Gland.

Some diseases of other parts of the uro-genital apparatus have been treated by massage. These are :—

Organic Stricture of the Urethra.

Geyza Antal used *massage through the perineum* along with the other usual dilating treatment with bougies for these diseases, so common after persistent gonorrhœa. The object of this is to remove the peri-urethral submucous infiltrations which cause the stricture. In a few cases during the last few years I have used this treatment, in itself entirely rational. It is necessary first to locate the seat of the stricture, which is easily done by inserting a coarse bougie, which stops at the first part of the stricture, and the point of which, in most cases, can easily be felt through the perineum. After having removed the bougie, frictions are performed, not too gently, for several minutes on the area of the stricture.* The patient may easily be instructed to carry out this treatment himself morning and evening, which, in order to avoid too strong mechanical irritation, should be done at other times than the dilatation with bougies (gradually increasing in size). I consider that dilatation can be considerably facilitated by massage.

* Hünerfauth mentions in talking of massage for stricture that the prostatic and membranous portions of the urethra should be massaged per rectum. It is, however, well known that stricture may arise anywhere in the urethra *except* in the prostatic portion. It is usually found, as Sir Henry Thompson and many others tell us, at the front of the membranous portion just where it joins the bulbous portion. The front part and the whole of the length of the membranous portion can, however, be particularly well worked upon from the perineum. So that I cannot see that it is necessary to massage stricture per rectum, and since one has the choice the majority would prefer the perineal method.

Residua after gonorrhœal epididymitis is massaged by Colombo, who begins this treatment six weeks after the inflammation is over, and considers that it can prevent sterility.

Brandt treated *nervous cramp in the bladder*, either in the detrusor muscles with spastic enuresis or in the sphincter muscles with spastic dysuria, by depleting exercises and massage of the arms and (especially) of the legs, as well as by frictions upon the organ from the vagina. Others also have used mechanical treatment to bear upon *atonic conditions in the bladder*, and this must be reckoned as massage, more particularly as tapôtement. Zander used several of his machines for these, and gave hackings on the spine to act upon the corresponding nervous centres, and applied shakings more directly over the bladder by letting the patient sit astride an upholstered board, vibrating up and down (generally used for the legs and feet), or by letting the patient support himself with the abdomen against the terminal of a lever vibrating from side to side immediately above the symphysis pubis. Many perform bladder massage by pressing the three middle fingers against the patient's abdominal wall as he sits opposite the doctor, and applying vibrations downwards. Narich massages for incontinence of urine in women with the forefinger in the vagina, first in the region of the neck of the bladder by strokings and vibratory manipulations, and later over the urethra. Cillag and Rawikowitsch massage for nocturnal enuresis with the index finger of the left hand in the rectum in the case of men and girls, in the case of women in the vagina, and with the fingers of the right hand as a help on the skin just above the symphysis, applying vibrations to the neck of the bladder, and obtaining good results after one or two weeks' treatment. In all these cases I should prefer vibrations over the symphysis with Zander's or other apparatus. In cases occurring in childhood I consider it far better to await the onset of puberty, which pretty certainly will bring recovery, and I consider all massage in and around the sexual parts a misuse of this treatment.

Chronic Prostatitis and Hypertrophy of the Prostate.

Estlander of Helsingfors first began to massage these diseases in 1877. Later Rütte obtained complete cure by means of massage in cases of retention of urine due to hypertrophy of the prostate. Estlander considers massage to be useful in cases of infarct as well as of induration. In two cases of senile hypertrophy of the prostate, however, Estlander obtained no distinct improvement, but the massage treatment was certainly of short duration. Massage must be applied by frictions on the prostate through the rectum.

CHAPTER XX.

THE NERVOUS SYSTEM.

During the last ten years massage of the *peripheral nerves* * has become much more extensively used, since the diagnosis of neuralgia is so often replaced by that of neuritis, for which the benefits of massage are obvious.

Insterstitial neuritis of rheumatic or other origin, with inflammatory increase of connective tissue, but with unaltered or almost normal nerve fibres, is that which best lends itself to massage, and is extremely common, usually as a bye-product of processes which have spread by contiguity to other parts, especially to the muscles.

Sometimes, especially in the case of the nerves of the face, and particularly with the supra-orbital nerve, one is able by means of palpation to feel the thickening of the nerve † *as a result of interstitial neuritis*, so that it either feels thickened in the whole of its length, or localised swellings lead one to diagnose a "neuritis nodosa disseminata." The easiest method of examination is first to knead the surface with a lubricant, then by palpation with the tips of the fingers glide forwards and backwards over the nerve trunk at right angles to the axis, then carefully compare the result of palpation with the normal nerve trunk on the healthy side. If one thus succeeds in changing the more general diagnosis of "supra-orbital neuralgia" or "facial cramp" to the more satisfactory one of "supra-orbital or facial neuritis" or "perineuritis," one works most during massage treatment by frictions over the changes present, but without neglecting to treat the nerve in its whole length by other manipulations, even where palpation gives only a negative result. One lays greater stress on working over those parts where the nerve emerges from an opening in the bone (*e.g.*, the supra-orbital foramen), or where it passes through a muscle (*e.g.*, where the great occipital nerve becomes cutaneous by piercing complexus behind the mastoid process), or where it perforates

* Massage of peripheral nerves was mentioned at least as early as 1758, when Fordice wrote, in reference to hemicrania: "Compressio vel frictio nervi, qui cranium supra oculi orbitam perforat, aliquando dolorem lenit, nunquam delet." Cotunni spoke of massage of the sciatic nerve. Balfour of Edinburgh used nerve massage about 1820, and many other historical references exist.

† Reinhardt Natvig f Christiania has collected earlier accounts of pathological changes in the nerves. We find, among others, that Tournilhac-Beringier in 1814 found the sciatic nerve thickened to three times its volume in a case of sciatica, and that Astley Cooper found the infra-orbital nerve atrophied in a case of neuralgia.

fascia (*e.g.*, where the lateral branches of the intercostal nerves become superficial in the intercostal spaces). It is in such places, corresponding to the " puncta dolorosa " of Valleix, that we generally find the most marked evidence of chronic inflammation felt as small swellings.

In many cases one cannot feel the nerve by palpation, but must rely in the treatment on one's knowledge of topographical anatomy, and if there is reason to suspect an interstitial process the nerve should be treated in as large a part of its area of distribution as possible by frictions, the most important manipulation in cases of interstitial neuritis. This should be followed by the ordinary nerve massage, vibrations, and effleurage.

Pure " parenchymatous neuritis " which is a degenerative process whereby the myelin sheath and the axis cylinder lose their outline and gradually become granular and indistinct, till at last they are destroyed and reabsorbed, differs in many practical respects from interstitial neuritis, especially for the masseur. In examination one cannot always expect to feel the nerve by palpation, nor can one always find a definite tenderness to pressure over its branches. The process has often crept on so insidiously that the changes are considerably advanced before the patient has sought medical advice. He may often have felt in a definite region, generally in the leg, trembling, vibrating pains, which Englishmen call " tingling sensations." In most cases no pronounced motor symptoms are found. *The most important treatment in such cases is always simple effleurage, lightly carried out for nutritive purposes over the whole or the greater part of the limb. However favourable may be the conditions for this manipulation, especially in the lower extremities, which are most often affected, such cases seldom give a satisfactory result.* Considerable experience, especially in cases of alcoholic, diabetic, and gouty parenchymatous neuritis, has taught me that even in slight early cases, and even when one can remove the cause, as is sometimes the case in alcoholic neuritis, therapeutic results are slowly obtained. When the causes of the disease remain the results are still less satisfactory. When a patient has suffered from diabetes for many years, and begins to experience the unusual symptoms of paralysis of the leg, especially loss of dorsal flexion in the ankle joint, which paralysis is due to neuritis, not to the changes in the posterior horn of the spinal cord present in diabetes, one can retard the development of the process by massage and gymnastics, but the final result, if the patient lives any length of time, is local paralysis.

Pure neuralgia, by which we mean peripheral nerve pains of central origin and other pains for which we cannot discover any peripheral cause, *is treated peripherally by effleurage and vibrations*

(see later concerning Central Nervous Diseases). In these instances, as in many others, we must not neglect the help of electricity and other therapeutic means. Hot-air baths especially are of great value. (The best apparatus is the Bier-Eschemann.)

In *nerve injuries* massage is used for the same reason as has already been given in speaking of injuries in general, and here again it is effleurage which encourages healing, counteracts inflammation, etc., and frictions which remove inflammatory products. In contusions, where there is a disturbance of sensation and mobility (with marked variations), and not seldom also changes of a trophic nature, it helps to bring the process to a rapid and favourable end. This is often the case after injury where there has been hæmorrhage, or after operation, especially after the modern nerve suture (Tillman's). In these cases it is of course necessary to wait until the skin is completely or almost healed before beginning massage, which must be given over the respective muscles as well. Other treatment, particularly electricity, is generally given at the same time. It is evident that one can only expect a satisfactory result when there has been aseptic healing, which gives hope of recovery of conduction. When scar formation takes place round the central and the peripheral stumps of the nerve, and when a considerable space is left between them, no treatment is of any avail except operation and suture of the nerve.

The remarkable "*sleep paralysis*" which comes on suddenly at night, especially in the area of the musculo-spiral nerve, often in young healthy individuals, probably by pressure or pinching of the nerve, especially where it pierces the external intermuscular septum, disappears in a few weeks or two months under treatment by effleurage, gymnastic, and electrical treatment.

The treatment of supra-orbital neuritis and sciatica may be taken as an example.

Supra-orbital neuralgia or neuritis (*with or without symptoms of migraine* *) is a nerve disease which often gives pronounced phenomena on palpation. Such cases require very careful examination on the lines spoken of above, as small swellings over the nerve trunk after it emerges from the supra-orbital foramen, as well as painful points with or without palpable changes, are often found

* I group together supra-orbital neuralgia and migraine, as most English, American, and French medical men do. The Germans are still generally of another opinion, since Du Bois-Reymond in 1860 described migraine as a primary vasomotor neurosis. Professor Henschen, who carefully analysed 140 cases, remarks upon and demonstrates in detail in his useful book ("Studier öfver hufvudets neuralgier": Upsala, 1881) the impossibility of distinguishing different forms of the disease, an opinion which is accepted not only by Scandinavian but also by German authors. For my part I believe that those who are accustomed to treat these cases by massage, and therefore are accustomed at the same time to lay more stress on palpation, would be the least inclined to make a separate class of those forms in which the vasomotor and eye symptoms are most prominent.

over the whole extent of the nerve. The separate nerve trunks near the supra-orbital foramen can often be felt thickened, and one finds tender cord-like swellings (which occasionally can be seen on account of their prominent position on the forehead).

In all examinations of supra-orbital neuralgia it is important not only to examine that nerve, but also the other cutaneous nerves of the head. Supra-orbital neuralgia is often due to rheumatism,* which also affects other nerves, commonly the facial, occipital, and auriculo-temporal. Although changes in these nerves are seldom palpable, the nerve trunk may be more or less tender and must be treated in the whole of its course. Both the inferior branches of trigeminus, with their smaller branches, must be examined, although they are less often affected than the above-named nerves. One must also further examine other parts than nerves, observe if the skin, as is often the case after lengthy processes, is thickened and œdematous (it is best to lift a fold of skin on either side and compare them), and notice also if there is infiltration in the neighbouring muscles.† Finally one must ascertain if there is pain on pressure on the same side of the neck over the two superior sympathetic ganglia; if present, this must be treated by fairly strong frictions.‡

* Of Henschen's 140 cases 106 had rheumatic symptoms in other parts of the body, three had absolutely none; in the 31 remaining cases such symptoms were at least not noticeable. Henschen points out that supra-orbital neuralgia is more often combined with neuralgia in the occipital nerves than in the two lower branches of trigeminus, and he therefore considers the spread of the disease peripherally through chronic rheumatic inflammation to be more common than its spread through central irritation. It is certain that supra-orbital neuralgia, with or without the special symptoms of migraine, is often found in persons who are thoroughly rheumatic, and where palpation gives reason to diagnose the existence of rheumatic infiltrations in the nerves, muscles, and subcutaneous connective tissue in various parts of the head, and in whom the trouble is of a rheumatic kind, since they are affected more by changes of weather than by anything else. It is just in these cases that one may expect beneficial results from massage. However, as always, one ought in these cases to consider the possibility of several co-operating causes, and not forget the effect that poisons (mercury, lead), infections (malaria), dyscrasiæ (syphilis, chlorosis, gout, diabetes), or by reflex action diseases of the digestive organs or uro-genital apparatus, may have in causing supra-orbital pains, and then use not only massage, but also other means indicated by the causal disease. Also it is necessary to remember aneurism periostitis, etc., in the head, and before massage is begun it is necessary to exclude the possibility of purulent and tubercular processes, etc. I know of one case where a little Swedish girl was treated with strong massage almost up to the day of her death from intracranial abscess by a professor and doctor of medicine, whose mind was preoccupied by the idea of peripheral irritation of the branches of trigeminus by rheumatic infiltrations.

† Since the soft tissues on the head are so thin, it is quite impossible to make what is in any case rather a difficult diagnosis between subcutaneous infiltrations in the connective tissue and in the muscles. They are often found combined; each may exist alone, and both are common, although infiltrations in the connective tissue are often taken for the more troublesome myositis (very fashionable now among masseurs). Infiltrations in the head, if at all extensive, invade the various tissues in their neighbourhood. They are treated best by performing small frictions or kneading with the pads of the three fingers close together at right angles over the affected and œdematous area, so that they reach the muscles, nerves, and connective tissue (Fig. 6, p. 26).

‡ Henschen, in his work described above, has spoken of the tenderness to pressure over the cervical ganglia in cases of supra-orbital neuralgia remarked upon by many authors as very common, and he found this present in 91 cases out of 112 (?).

There is little to add to the above concerning massage for supra-orbital neuritis (or neuralgia). One massages first and foremost all those parts where changes are found on examination, viz., the nerve trunks, by all three manipulations already mentioned, as well as the other parts (muscles, skin, and subcutaneous tissue) by friction and effleurage. In cases where no palpable changes have been found it is best to work according to the above rule as if they had been found, laying greatest stress on the work in the places where they are most common, *i.e.*, of course near the supra-orbital foramen.* It ought not to be necessary to remind my readers that effleurage ought always to be given in the same direction as the venous blood flow (frontal vein), that is, from the frontal and temporal regions towards the root of the nose. My only reason for calling attention to this is the fact that I have often seen masseurs work in the opposite direction.

The treatment must often be given for a long time, weeks or months. Henschen was successful in twenty-four out of twenty-nine cases in obtaining either improvement or cure. My own experience has given improvement as the general result ; complete recovery has only been effected in the minority of cases. Pain, tenderness on pressure, the pure symptoms of migraine (viz., vomiting, nausea, ocular phenomena, etc.), and muscular tremors are sometimes quite unaffected by massage treatment. In one case of a well-known German Wagner singer, who from time to time alarmed his enthusiastic audience by horrible involuntary grimaces, I treated him without being able to ascertain the cause, with almost or quite a negative result, by massage over both the facial nerve and the branches of the trigeminal for several weeks. In other cases one often performs " miracles " with the utmost ease and in a very short time.

Sciatica is now generally treated by massage in all Teutonic countries, and there are many reports concerning the value of the treatment, which has markedly increased the prospect of recovery.

We might equally well have dealt with sciatica in the chapter on Diseases of Muscles, for it is, to a great extent, of myogenic origin, and is caused by myositis in the neighbourhood of the nerve trunk, especially in gluteus maximus and medius, while anæmia, chlorosis, hysteria, and the neurotic tendency are here of less ætio-

* In one or two severe cases, where no changes on palpation were to be found, in experimenting with strong frictions over the supra-orbital foramen I succeeded in stopping the neuralgia ; in one case only, which I had the opportunity to see again, the freedom from pain remained for at least several weeks after treatment. In a third case, where I adopted the same treatment, I only brought about a violent attack of migraine, for which reason I have not again used this method, though it may be of some value.

logical importance than in other forms of neuralgia (especially those arising in the nerves of the head). Of the general causes diabetes is the most common, and the possibility of its existence should not be forgotten. The possibility of pressure from tumours (either in the uterus or elsewhere in the pelvis) as a cause must also be considered. *It is evident that massage is of the greatest value when rheumatic changes in the muscles are the cause of neuralgia.*

In sciatica the most important examination by palpation is to decide how much infiltration there is in the gluteal muscles, and this is done by the method already explained. Such infiltration, however, for anatomical reasons may easily escape the masseur, and here, therefore, especially for myself, I make it a rule, even if no changes are palpable, to apply strong massage with frictions over the gluteal region. Besides this it is necessary to give strong vibrations over the great sciatic nerve from the popliteal space upwards, and it is also well to give strong effleurage over the whole leg. (It is of course important to examine for myositis all along the course of the nerve.)

Finally, "*Nerve-stretching*" plays an important *rôle*, for anatomical reasons, in the treatment of sciatica. It is best given, after turning the patient from the prone to the supine position, by the masseur placing the patient's leg on his own shoulder and his hands on the patient's thigh just above the knee in order to prevent flexion of the knee joint; he then performs flexion in the hip joint as far as the patient can bear it.

The treatment of sciatica by massage, when the causes are not of a permanent nature, gives a fairly good result. During the last eleven years my experience in these cases has considerably increased in my mechano-therapeutic clinic, and I can definitely say that a negative result is rare, and that a temporary cure or improvement is more usual than permanent cure. The same result appears in many other papers on the same subject by Berghman, Craith, Douglas Graham, Faye, Gussenbauer, Johnsen, Norström, Winge, Zabludowski, Bum, and others. The treatment, however, must often be continued for some months.

Later experience has justified in cases of sciatica the injection under the glutei of about 100 grm. of a weak solution of novocaine, which is often said to have a markedly curative effect.

* * * * *

In diseases of the *Central Nervous System* massage and gymnastics play nowadays important parts. The brilliant results obtained by Frenkel's compensatory gymnastics in cases of ataxy with tabes have made it the duty of every doctor not to neglect that part of

the treatment, and have also stimulated interest in systematic exercise for all disturbances of the motor nervous system.

In massage for diseases of the central nervous system the muscle centres are acted upon through the peripheral nerves with which they are in physiological connection. Long ago, however, *it was found that if the nervous centres could not be directly treated they could in many cases be strongly affected by vibrations over the cranium or spine.*

Treatment by vibration in diseases of the central nervous system is an old method of treatment. Abbé St. Pierre invented in 1734 his "tremoussoir" or "fauteuil de poste" for sedentary people; it was widely used and praised as having a beneficial effect on the nervous system, and even won the approval of the hypercritical Voltaire. In the present day there are many forms of vibratory apparatus, which act on diseases of the central nervous system. Among the Zander apparatus since 1868 there is a semicircular padded metal plate which vibrates from side to side, and is placed over the cranium and comes into contact with the head on either side alternately. This, in my opinion, is the best of all vibratory apparatus used for insomnia. In Charcot's clinic in La Salpêtrière in Paris, in 1878, Vigouroux performed vibrations by means of an enormous tuning-fork and a sounding-box; by these means he succeeded in removing hemi-anæsthesia and contracture in hysterical patients and relieving the shooting pains of tabes dorsalis. Boudet in Paris, in 1880, worked by means of a tuning-fork driven by electric power, the vibrations of which were carried to a sounding-box of wood and thence to a small point or plate supported by a metal stem; he thereby produced local anæsthesia and analgesia and cured neuralgia. In Italy Morselli and Buccola used a similar apparatus for melancholia, insomnia, and neuralgia. About this time, too, in England Dr. Mortimer Granville used vibration therapy for nervous and other disorders by means of an apparatus for percussion. I must also draw attention to two French apparatus, both of which were used in Charcot's clinic in La Salpêtrière in Paris, and which affected the cerebro-spinal centres by means of vibrations, one by vibrations on the head, the other by setting the whole body in vibration. One was "*le casque vibrant*," invented by Charcot's chef de clinique Dr. Gilles de la Tourette, and consists of a steel hood, which by means of a simple contrivance can be made to fit any head, and which is set in very regular vibration at the top by a little electric motor (about 6,000 per minute); the motor is quite isolated from the patient's head, and the treatment is therefore absolutely mechanical. I may add that "*le casque vibrant*" is used in treatments of about ten minutes' duration for neuralgia and migraine, especially for insomnia, as well as for the whole series of (cerebral and spinal) neurasthenic symptoms, and for cases of melancholia. The other apparatus, the "*fauteuil trépidant*," is an ordinary easy-chair which is set in vibration by manual means or by gas, electricity, water, or compressed air; it is used in treatments of twenty to thirty minutes and given to patients suffering from paralysis agitans; it was invented by Charcot, who had observed the good effect of railway journeys on such patients. This apparatus

also has its representative among Zander's machines, where there is a *vibrating board on which the patient can sit*, but this is more generally used to give vibrations over the legs. Quite lately M. Herz has invented a vibrating bed.

In *Psychoses*, also, vibrations have been applied to the central nervous system (through the cranium), and have often given positive results. In his lectures (see "Iconographie de la Salpêtrière": Paris, 1892) Charcot speaks of the probability of the beneficial effects of vibrations in such disorders; he also speaks of an instance of melancholia which seems to have been cut short by this treatment, and which, until the vibrations were begun, had shown no signs of improvement.

For local vibrations excellent apparatus exists which can be placed on the forehead, on the occipital protuberance, and on the sides of the head. Several minutes' vibration of this kind gave very good results in insomnia. Experience has shown that manual vibrations act beneficially in neurasthenic insomnia; in emotional psychoses they are sometimes beneficial, sometimes harmful; in cases of auditory hallucinations they are harmful.

We have also learnt that static pressure on the motor nerves removes spasms, *e.g.* in facial and spinal accessory cramp, and Frey has noticed that saltatory symptoms can be made to cease by pressure on the corresponding muscles.

It is worth remarking that the wonderfully good results of Frenkel's exercises for tabes must not make us allow them entirely to take the place of massage for this or other diseases of the central nervous system. Even before Frenkel's time very good results, especially in tabes, were obtained chiefly by massage in Stockholm, especially at the Orthopædic Institute. All four extremities were treated by effleurage, pétrissage, and tapôtement with vibrations over the nerves corresponding to girdle sensations or other sensory disturbances, over the spinal cord and over the bladder; in short, a strong general massage was given, specially adapted to the case. It was surprising to an onlooker to see the *great amount* of mechanical work which each patient received while in the hands of the doctor or an assistant during a full hour's treatment with very little pause.

As soon as motor symptoms appear gymnastic treatment is given, and all methods are used which facilitate movement in cases of paresis (see pp. 129—131). I must here remind my readers of the value of the so-called kineto-therapeutic baths, which are little known in Sweden, and the use of which I have come to know and appreciate since infantile paralysis has become so common.

Massage and gymnastics are therefore a legitimate and indeed an

absolutely obligatory method of treating diseases of the central nervous system, in acute cases as soon as the acute process has ceased, in chronic cases during the whole, or at least the greater part, of the course of the illness.

In Sweden similar treatment has been used with more or less good results *in shock, trauma, and hæmorrhage; in chronic myelitis and compression myelitis; in tabes dorsalis, hereditary ataxy, and multiple cerebro-spinal sclerosis; in amyotrophic lateral sclerosis; in progressive muscular atrophy and pseudo-hypertrophic muscular atrophy; in paralysis after acute anterior poliomyelitis; in toxic paralysis, very often in the common lead paralysis; in co-ordination trade neuroses; in chorea, and in hysterical affections.*

It is quite unnecessary, after all that has already been said in the chapter on the Effects of Massage and Gymnastics and in this chapter, to give in detail the kind of treatment and the result to be expected in every kind of illness. Both massage and gymnastics are used on the above principles for the various functional disturbances, and *each one may easily devise his own method.* Here I purposely speak only of the treatment for tabes, chorea, co-ordination trade neuroses and hysteria, and shall then describe Weir-Mitchell's cure by rest, massage, and mud baths.

* * * * *

Tabes Dorsalis, (syphilitic) sclerosis in the posterior horns of the spinal cord, is treated now more or less all over the world by massage, and especially by gymnastics.

Frenkel's method of gymnastics has been equipped with extensive apparatus. In order to give gymnastics in this way expensively-fitted institutions are required—for example, such as those found at La Salpêtrière in Paris and Frenkel's own institution at Freihof in Heiden, as well as the Moabite Hospital and Professor Leyden's Hospital in Berlin. The private practitioner and the private patient can only on exceptional occasions make use of similar establishments, for the description of which I refer my readers to the many special works on the subject. It is satisfactory to know that this elaborate apparatus can be easily dispensed with and that Frenkel's method can be effectively used by means of much simpler and cheaper appliances.

The chief object of compensatory gymnastics is to replace by some other form of sensation, especially the sense of sight, the sensation which has been lost by sclerosis of the posterior horns of the spinal cord, and to improve and train the centres of co-ordination and movement to perform their functions with limited sensation.

The exercises which are used in these cases are performed slowly,

and the patient tries especially to control them by the antagonists of the contracted muscles; compensatory gymnastics are therefore fundamentally self-resisted exercises (see pp. 131, 132).

In advanced cases attention must be paid to the *hypotonus* of the patient, to the diminished physiological resistance, and to the *faulty carriage of the body* which is sure to follow; for this purpose there are several different pieces of apparatus. In very advanced cases, where the patient finds it difficult to hold himself up, Frenkel has constructed a chest girdle provided with two handles on each side, one in front and one behind, by which assistants support the patient; necessary support can also be given by a "walking-chair," a hand-rail, or walking-sticks.

In all these movements the doctor must carefully decide the amount and character of the exercises, and never allow the patient to be fatigued. The patient is unable to decide this, for he will more or less have lost the sense of fatigue, which in normal persons is the intimation of muscular fatigue.

Exercises for the lower extremities are done in lying, sitting, or standing position, or walking.

If we make a choice of exercises from Frenkel's, Goldscheider's and Jacob's movements, we can compile the following gymnastic scheme, which requires very little apparatus, can be carried out in the patient's home, and is given with very satisfactory results. Those who wish for further details on the subject are referred to special works.

I. Exercises in Lying Position.

A. Flexion and extension of hip joint with extended knee (*i.e.*, with straight leg).
B. Flexion of hip joint, immediately followed by flexion and extension of the knee, and finally by extension of hip joint.
C. Dorsal flexion and plantar flexion in the ankle joint.
D. Rotation of hip joint with extended knee, so that the foot moves in a circle.
E. Climbing with the feet on a staircase or ladder of three or four steps inclined towards the patient.
F. Placing one leg over the other.
G. Gliding the heel of one foot over the shin of the other leg.

II. Exercises in Sitting Position.

A. Lifting the foot and knee, extension and flexion of the knee, sinking of the foot again to the ground.
B. Heel-raising.

C. Gliding alternately one foot after the other over a marked cross, forwards, backwards, to the left and right.
D. Going upstairs (steps, wall-bars, or ladder).
E. Nine-pins, in which the patient practises knocking down with one foot a certain ninepin out of a set which is placed in front of him on a single or double shelf in the shape of an amphitheatre.
F. Practice in sitting down and getting up.

III. Static Exercises.

A. Sitting.
B. Standing in a "walking-chair" * or without it, with feet closed and heels touching each other, or with abducted legs.
C. Standing on one leg.
D. Standing on tiptoe.
E. Standing on the heels.

IV. Exercises in Walking.

A. Walking on a dark track, 21 cm. wide, divided by light and fairly broad transverse lines into whole steps 61 cm. long and half-steps 30·5 cm. long.
B. Inside a circle to make a complete turn to the left with the left heel as supporting point, and again to the right with the right heel as supporting point.
C. To walk first in one, then in the other direction along a circular line on the floor.

In exercises for the upper extremities we need not trouble about faults in position, and we need only support in order to prevent fatigue. On the other hand, we must take more care as to the precision of these exercises than in those for the lower extremity. In order to practise these exercises the patient needs only two simple and cheaply-constructed pieces of apparatus, viz. :—

A. A blackboard and chalk. On this he must, with either right or left hand, change the sign — into +, or do some other exercise which demands the same precision of movement.
B. A board with a hole through it, and a number of pins which he must place in the hole with either the right or left hand.

For all the above exercises, in which sight is not essential, it is a question of exercising co-ordination, partly by means of sight, partly by the help of the other sensory resources normally used

* A walking-chair consists of a piece of wood with three side pieces and one side open, supported by four legs fitted with metal castors.

which are still left to the patient; and they should be practised with open as well as with closed eyes.

* * * * *

Co-ordination (Occupation) Neuroses (Benedikt).

The spastic, trembling or paralytic changes, which arise in one or more groups of muscles owing to constant fatigue and one-sided work of the upper (less often the lower) extremity, are in many instances undoubtedly accompanied by chronic inflammatory processes in the muscles or nerves of the arms or legs, which is probably due to over-fatigue of a certain group of muscles and the associated constant hyperæmia. In other instances there may not be the slightest visible sign, not even tenderness on pressure, to indicate similar or other peripheral changes. Since nervous, hereditary, and purely psychical influences often play a decided part, and signs of defective nutrition are found in distant groups of muscles (such as the eyes, tongue, larynx), and there are also sensory symptoms, we are justified in considering some of these cases as essentially central neuroses. At the same time we must not forget the possibility of a peripheral pathological-anatomical origin and in each case try to discover it by careful palpation over each possible nerve and muscle, and we must, especially in the case of muscles, take tenderness on pressure as sufficient proof.

As is well known, all kinds of craftsmen whose work is one-sided are liable to suffer from co-ordination occupation neurosis. Writers, pianists, organists, violinists, players on the zither, harp, etc., shoemakers, typists, bricklayers, sawyers, weavers, watchmakers, smiths, draughtsmen, cigar workers, laundresses, telephonists, as well as masseurs and others, have shown similar symptoms (hence the old name writer's cramp is less rational than Benedikt's now accepted title). In all the occupations where the arms are used it is especially the muscles of the hand and the flexors of the forearm which suffer from tonic cramp, tremor or paresis, but the whole group of arm muscles, as well as those of the shoulder, neck and chest, may be affected. In dancers it is generally the muscles of the big toe which are affected, in cyclists the muscles of the thigh.

The treatment of occupation neuroses by massage is now generally recognised. Of equal importance is *rest for the respective muscles from fatiguing work, but especially rest from that occupation which has caused the affection*, and also the use of the galvanic current over the muscles and peripheral nerves as well as the brain and spinal cord, along with attention to the general indications of the case. Many people use, in addition, gymnastics with passive and active, simple and combined movements, for which different apparatus may be used. *Slow self-resisted and fully controlled exercises here play*

the greatest part. For my part I never use gymnastics, because rest is required in the treatment of fatigue neuroses, and also because massage, together with the unavoidable movements of daily life, is more than enough to prevent any danger from inactivity.

The technique of the treatment consists of strong effleurage over the veins along the whole extent of the affected part, as well as massage of the respective groups of muscles by effleurage, pétrissage, and tapôtement. In all these cases I am in the habit of giving fairly strong massage. Some authors (*e.g.*, Eichhorst) prescribe a "cautious" (*i.e.*, gentle) treatment. Hünerfauth uses stronger manipulations in spastic and paretic cases, gentler when tremors are present. Some masseurs lay stress on the treatment of nerves in so far as they are accessible.

All this depends on whether anatomical changes are evident; if they are, the treatment should exclusively or to a large extent be guided by them.

A co-ordination occupation neurosis is an obstinate disease which responds to treatment very slowly, and easily recurs when the one-sided muscle work is resumed.

The treatment often lasts several months.

For the rare, often hereditary, *primary spinal muscle spasm* (= *Thomson's disease, myotonia congenita*) massage has been used, on Erb's advice, in combination with baths, electricity, and gymnastics.

For the curious *attacks of saltatory cramp*, dependent probably upon an increased reflex from the ganglia in the anterior horn of the spinal cord, the same treatment is permissible for the reason stated by Frey, that by pressure on the muscles it is possible to relieve cramp (probably by the simultaneous pressure on the nerves).

Finally, it does not seem improbable that at least some forms of *tetanus* may be influenced by massage between, or even possibly during, the attacks.

Chorea.*

The majority of my readers have probably frequently thought that the number of methods in use in treatment of a disease is in inverse ratio to the effect of these methods. A great part of the pharmacopœia, and many methods which would otherwise be foreign to medicine, have been used in the treatment of chorea.†

* I mean exclusively the usual chorea (chorea minor), whether single or double-sided, and not the prominent motor symptoms, known as chorea major, present in marked psychoses, hysteria, simulation, etc.

† On the whole, mechano-therapy has been comparatively successful. In 1799 Erasmus Darwin suggested mechanical treatment for chorea. Swedish gymnastics, under the elder Ling, was also used in its treatment. Southam of London deserves to be honourably mentioned; he suggested in 1841 immobilisation alternately with passive movements and after-treatment by gentle gymnastics. In 1850 the treatment of chorea by massage and gymnastics came into vogue in France through See, Blache, Laisné, Bequerel, and others. Mechanical, along with other treatment, is now commonly used.

It is still far from easy to decide to what degree each part of the mechanical treatment contributes in relieving and shortening the duration of this erratic disorder, which may last weeks or years, may entirely disappear or recur, without satisfactory answers as to the cause of the disease, whether it is combined with endarteritis or with rheumatism, with chlorosis, hysteria or pregnancy, and whether it arises, as usual, at the beginning of the second decade of life or later.

The mechanical treatment consists of immobilisation, massage and gymnastics, and I personally consider that the value of these three therapeutic methods is in the above order.

I would specially point out that immobilisation must so far be considered the best (*Nebel, Monahan, Nönnchen, and others*). *It may be brought about by means of a plaster jacket and by plaster bandages on the extremities, which are later changed to movable splints and taken off once or oftener daily to allow of massage.*

Massage is indicated, when immobilisation is used, to counteract its effects, and also to act upon the pathological-anatomical changes which are to be found, whether they result from or are the cause of the muscular excitability, and which Elischer describes as hyperæmia in the vasa nutrientia of the nerves, hypertrophy of the interstitial neurilemma, flattening of the contour of the myelin sheath and axis cylinder, and a decidedly abnormal macroscopic appearance of the nerve fibres ("*verschmächtigt, abgeplattet und abnorm derb, von schmützig grauer Färbe*").

As regards gymnastics, many hold Ziemssen's opinion that it really belongs to the stage of recovery, at least in severe cases. *It ought certainly to consist of passive movements and of progressive self-resisted movements*, during which without doubt the movements are most easily performed under the control of the will; other active movements should be kept for the more advanced stage of convalescence.

Along with immobilisation and massage, chiefly effleurage and self-resisted movements, the anodal* galvanic current should be used on the spinal cord and peripheral nerves, the physical and mental diet should be controlled, and for the rest the ætiology of the case (chlorosis, peripheral irritation of one kind or another) must decide.

It was in Charcot's clinic that Vigouroux in 1878 first succeeded in treating *hemianæsthesia and contracture* in *hysteria* successfully by vibrations. Insomnia also in these cases was improved by vibrations on the head (Buccola). After what has been said in the

* I would remind the reader of the observations by Legros and Onimus upon choreic dogs on the diminution of the movements with an anodal current and increase of the same with a kathodal current.

general part of the chapter there is little to add concerning the massage for hysteria. From what has been said above it is easy to see how sensory, motor, and other symptoms may be treated in this way, which naturally can never be more than an accessory to other treatment. Owing to the nature and character of the disease itself, as well as to the absence of pure therapeutic experiments with massage, no one is in a position to estimate its value with certainty, although it appears to have the same influence upon the special symptoms as it has in those neuroses of which the pathological anatomy is known.

Neurasthenia.

The massage treatment of neurasthenia consists of vibrations on the head and spine, and, especially when there are peripheral nerve symptoms, of general massage, modified according to the peculiarities of the case; and this is all that can be said without tiring the reader with unnecessary repetition. Charcot claims that the vibrating helmet removes giddiness and the painful pressure over the head, and that after eight to ten treatments (for ten minutes, preferably about 6 p.m.) sleep returns. The spinal symptoms also, according to Charcot, are strongly affected; pains and aching in the sacrum are relieved, weakness in the legs disappears, and sexual potency returns. I have made some observations on the effects of vibrations in neurasthenia (influenced by Charcot's lecture given by Gilles de la Tourette on the subject), and received the impression that the matter is well worth considering. The effect of vibrations on the head for insomnia especially is undeniable. The Zander machines, however, are too strong, and should not be used in cases of old people or where there are atheromatous processes in the blood vessels, etc., partly on account of the shaking itself, partly on account of the undoubted contraction of the vessels produced. In conjunction with the effect of massage for neurasthenia I now come to a special therapeutic system which has arisen in our day, specially designed for, and admirably suited to, a certain class of patient whom we usually call neurasthenic. I pass on now to what, in my opinion, is very important in practice, viz. :—

The Weir-Mitchell Treatment.*

This consists of complete rest in bed, isolation, high feeding, massage, and electricity.

* Dr. Weir-Mitchell of Philadelphia has the honour of having introduced this simple and well-arranged treatment. His work on this subject, "Fat and Blood and how to make them," made an enormous impression both in America and Europe, and was translated into German ("Der Behandlung gewisser Formen von Neurasthenie und Hysterie": Berlin. 1887)

We may begin by stating that the cure is meant for emaciated patients, especially those who are below their normal weight, and often at the same time anæmic, over-worked, and neurasthenic (or hysterical).

Weir-Mitchell used the cure especially for women patients. If the cases are well chosen it is excellent also for men, who formed the majority of my own cases.

In my opinion the indications for the cure, as stated by the genial author of it, are too extensive. Contrary to Weir-Mitchell, I do not use the cure for stout neurasthenics because of my experience in these cases. The corpulent neurasthenic, unlike those who are below normal weight, does not benefit his weak nerves by becoming fatter, and obesity, which is always detrimental, may be produced by the prolonged rest, combined with high feeding; this in particular may affect the heart badly. One of the chief aims of the cure is, therefore, in these cases a disadvantage. Weir-Mitchell tried to remove this by modifying the diet given to stout patients; they, as is often the case with others, were put exclusively upon skimmed milk, but the quantity was reduced to a litre a day. When we consider that, even while resting, 30 calories for every kilogram of body weight are required each twenty-four hours to maintain equilibrium, and that the value of 1 litre of cow's milk which has lost the greater quantity of its fat does not reach 400 calories, it is easily seen that this diet alone is not even a living amount, but is pure starvation. The patients also do become thin under it to a certain extent. But in my opinion under no circumstances should thinness be produced in neurasthenic patients by means of too restricted diet; they become extremely nervous, as I have often had the opportunity of observing, although this deterioration is less noticeable during rest and is partially counteracted by the other parts of the treatment.

Weir-Mitchell, who was warned by some unsuccessful attempts, does not consider his cure suitable for persons suffering from definite melancholia, and this opinion is shared also by Goodall and Playfair. The kind of mental disease and the individuality on the one hand, together with the manner in which the different parts of the treatment (particularly the isolation) are carried out on the other hand, may possibly have some influence; one would expect *a priori* that the cure would give good results in certain milder cases of melancholia.

The rest in bed gives the most complete rest the patient can obtain, not only for his muscles, but for his mind; it relieves him of the numerous changing impressions and emotions which he meets

with in daily life. Further, he is in a position to store up fat, which would otherwise go towards maintaining physical movements. In many cases also it has the great advantage that it makes the patient healthy, owing to the suitable surroundings chosen by the doctor, and does this independently of the patient, who is demoralised by hysteria or neurasthenia. It is easily seen that this is a most important part of the cure, a *conditio sine qua non*. But we must remember that massage can never take the place of physical exercise in its effect upon the heart and ventilation of the lungs, and that a too continuous rest in bed produces a lowered condition of nutrition. For this reason, when it seems suitable, I allow the patient to take an hour's walk every morning. The rest in bed is otherwise only broken by the patient's daily visits to the bathroom and lavatory, by the evening bed-making, and by weighing the patient once a week if desired.

Isolation aims at giving the patient complete rest of mind, and is certainly of value, but is not equally applicable to all cases. The doctor ought to try to obtain knowledge as quickly as possible of the character of the patient in order to deal rightly in this matter. One patient is extremely irritable and requires as complete isolation as possible; another, though in other ways extremely nervous, is not specially so in this respect, and can bear one or two visits daily from friends, especially if these refrain from discussing matters which excite him, especially his health. Some natures cannot under any circumstances bear long isolation. As a rule one must remember that isolation from the members of his own family is the most important. Although on the one hand one ought always to insist upon a certain amount of isolation, I think, on the other hand, that if one is too pedantically strict in this, and does not sufficiently consider the individual, one may miss the best results of the treatment.

Combined with the personal isolation we must also consider what we may call intellectual isolation. The patient may only read for a short time each day; if he suffers from asthenopia, which is not unusual in these cases, he may have a reader for an hour. The newspaper is, as a rule, the least harmful literature.

The diet must be arranged to strengthen and nourish the patient. It ought, therefore, to supply the three different kinds of foodstuffs in large quantities and proper proportion, and aims at putting as little strain as possible on the patient's digestive organs, and avoiding functional disturbance. Milk alone is not satisfactory in these respects for an adult; moreover, very large quantities would be required to give what may be considered a normal amount for a

person doing moderate work and a suitable amount for one resting.* One very often sees persons who under normal conditions do not suffer at all from disturbances of digestion, but who cannot take large quantities of milk, not even along with a mixed diet, much less as the one and only food ; they get pyrosis, eructations, flatulence, bad taste in the mouth, furred tongue, loss of appetite, constipation, and it is seen that an exclusive milk diet is not the most strengthening and the best tolerated by the digestive organs. These and other obvious reasons have led me to drop the diet used by Weir-Mitchell, and after him by many others.†

I give instead a mixed diet, which in cases of disturbances of digestion at the beginning follows exclusively Leube's diet-sheets arranged for patients with gastric ulcer.‡ Among these is unskimmed new milk in large quantities for such cases as can take it, and a certain amount is always given. Besides this the patient is given eggs, chicken, sweetbreads, pigeon, brains, minced or scraped beef (raw or grilled), roast beef, beefsteak, venison. Good butter is also allowed in most cases. Carbohydrates are represented by wheaten bread (not too fresh), well-cooked rice, mashed potatoes, and macaroni. To the extent to which the patient is free from dyspeptic or other digestive symptoms the list is extended by other things, such as fish (except salmon and eel), oysters, cooked fruit, etc. The patient has four meals a day, divided by about four hours, *e.g.*, at 8 a.m., 12 noon, 4 p.m., and 8 p.m. The

* If we take unskimmed milk as containing 3·5 per cent. proteid, 3·5 per cent. fat, and 5 per cent. milk sugar, which is fairly accurate, and, further, if we take the net value per gram of the three different foodstuffs to be respectively 3·2, 8·4, and 3·6 calories, we find that a litre of this milk gives under 600 calories. (Milk sugar is below the average for carbohydrates ; its value is 3·6 calories). Since in the Weir-Mitchell treatment, which in the case of a thin patient aims at fattening, we wish to give the patient at rest at least as many calories as a person doing average mechanical work, say, 35 calories for each kilo body weight, we find, *e.g.*, that a patient of 70 kilos weight, in order to receive the necessary 2,450 calories from exclusive milk diet, must drink over 4 litres unskimmed milk in twenty-four hours, which would not appreciably increase his fat. If skimmed milk were drunk over 6 litres would be required ! But how many people are able to drink that quantity without dyspeptic symptoms ? Those who, in spite of daily experience, obstinately persist in the belief concerning the excellence of cow's milk compared to all other food should consider two facts stated by Rubner : (1) That cow's milk, which is suitable for children, falls short by 8 to 12 per cent. of the nitrogen required for an adult ; (2) that the deficit in nitrogen is more serious when milk is given alone without other foods.

† Weir-Mitchell (in his fourth edition) gives at first milk only to those thin neurasthenic patients whom alone I should consider suitable cases for the treatment (*e.g.*, 120 grm. every other hour). Very soon mixed diet is given, and after ten days the patient receives three meals daily and from 60 to 120 grm. malt extract before every meal. Weir-Mitchell also gives iron as soon as the exclusive milk diet ceases, and from the third week, in severe cases, also cod-liver oil (15 grm. after meals, by the mouth or rectum). Later he nearly always gives strychnine, and sulphur with iron or arsenic. For my part I have never used exclusive milk diet other than for a few nephritis patients, where the chief object is to lessen the work of the kidneys, and where with this diet we often obtain very good results, which are easily understood when one considers the marked changes in the urine which occur on this diet.

‡ Instead of all these things being added successively to the diet, as in the case of a patient suffering from gastric ulcer, patients undergoing Weir-Mitchell treatment take them all at once and in larger quantities.

milk is given in small quantities during the day with and between meals.

The patient should take no alcoholic drink, or, if any at all, only small quantities of Pilsner, claret, cognac, or whiskey; the two last are often given in milk.

So far I have never needed to give aperients during Weir-Mitchell treatment. If abdominal kneading is well done they should very rarely be necessary.

Throughout the cure the patient usually sleeps well, even in those cases where insomnia was present. Formerly I usually avoided giving narcotics; latterly I have sometimes used veronal in small doses and combined with sodium bromide. Neither veronal, sulphonal, nor trional are so harmless as they are said to be, and they are bad for the heart. I do not care to give more than ·5 grm. for one dose, preferably with 2 grm. sodium bromide.

The cure allows of treatment with iron at the same time; this also depending upon the abdominal massage. If necessary I alternate the different preparations. I have, however, made use of Levico water containing both iron and arsenic. Roncegno is also good, but varies very much in the quantity of minerals it contains.

General massage is given; the most important object in the cure is as far as possible to let massage take the place of exercise, and prevent those discomforts which would arise through the patient's lying in bed so long.

Concerning the technique there is nothing further to say than that abdominal kneading and tapôtement of the muscles should be as thorough as possible, the latter as hard as the patient can bear without being irritated or unpleasantly affected by it, which point varies much. The head is always left alone. Massage can well be given twice a day, always at least once for three-quarters of an hour. The doctor has rarely time to do it himself, but can leave it to some trained person of the same sex as the patient.

General faradisation is given with slow intermittent current because of its well-known influence on muscles and nerves and its general tonic effect. The special muscles are first treated, then one electrode is placed at the back of the neck, and the other for a quarter of an hour first on the sole of one foot and then on the other. According to Weir-Mitchell electricity is the least important part of the treatment. This opinion I had already formed before reading Weir-Mitchell's work, after I had several times tried his well-known cure with excellent results, without once using electricity.

CHAPTER XXI.

DISORDERS OF NUTRITION.

In the preceding chapters we have seen that medical gymnastics and massage have a great effect on local and general nutrition. We know that effleurage has an important effect on the local circulation in cases of atrophy, it prevents gangrene (in frostbite, etc.), and is of great value as an aid to healing; that tapôtement in its various forms is useful in cases of disturbed nutrition of muscles and nerves; that abdominal massage, by improving absorption and peristalsis, is an indirect aid to nutrition. We have seen, further, that general massage has a similar effect by increasing the number of blood corpuscles. Gymnastics greatly influences metabolism; it increases the nitrogen in the urine and promotes the combustion of fats and carbohydrates to carbon dioxide and water. Massage, especially muscle massage, has the same influence to some extent, but in a much less degree.

The main therapeutic and hygienic value of gymnastics lies in its marked influence on circulation, respiration, and assimilation.

On these points our knowledge is very crude, and we are unfortunately ignorant as to the more intimate processes of nutrition. In illustration of our ignorance the reader is reminded how little is really known of intracellular life and of the mystery of trophic nerves, both of which remain a problem confronting us at every stage of investigation, when we attempt to trace the ætiology of those allied dystrophies, obesity, gout, and diabetes.

In comparison with the gaps in our knowledge it is relatively of slight importance that we have not mastered the problem of the expenditure of energy, *i.e.*, heat and movement in work. Generally it is assumed that of the expenditure of energy stated in terms of calories expended, two-thirds is converted into heat and at most one-third into work. According to Zuntz these figures are a maximum; Helmholz and others assume that only one-fifth of the calories used is expended by the human body in movement. I may repeat that for all patients with general disturbances of nutrition who are able to walk, gymnastics are best carried out by the terrain-cure, in which we cannot give detailed directions as to movements beyond the choice of slope. Meanwhile we may remember that expenditure in concentric movement is more costly

than in eccentric, since a greater part of the expenditure of energy is transformed into work in the former than in the latter. Movements involving ascent are largely concentric; conversely those involving descent are largely eccentric.

The reader is referred to what has already been said of Stokes' cure in the treatment of heart and lungs, since most of what has been said there refers equally to cases of obesity, gout, and diabetes. In these last cases, however, walking on an incline is of less importance than it is for affections of the heart and lungs, and any walks may be taken provided they are of adequate length.

Massage also plays an important *rôle*. General massage is then used with modifications to suit the particular case treated.

The importance of diet justifies a short section to itself.

Obesity.

We do not understand the cause of the great variation in the amount of fat present in different individuals; to my knowledge no comparative investigation has been made between naturally thin and naturally fat people, and with regard to the various foods which supply the required amount of calories, water and salts per kilogram of body weight in twenty-four hours. But we know for a fact that with people of about the same body weight the normal weight may vary considerably, *i.e.*, that each individual has a normal weight at which he feels at his best.

In estimating obesity it is necessary to remember not merely the correlation between the height and body weight * of the patient, but also the general condition of the patient, of his heart, nerves and muscles, and the amount of exercise he can take, as well as the presence or absence of other factors which may influence the amount of fat deposited.

Excessive corpulence may be checked in two ways: (1) *By appropriate exercise; and* (2) *by diminished food. We may remember that it is better to increase the amount of work the patient does than to limit his food supply, i.e., loss of weight is better obtained by increased output than by diminished intake. Our aim is not the patient's reduction to a certain weight, but rather the reduction to such a weight as can be obtained by vigorous exercise without excessive fatigue combined with suitable limitation of diet.*

Neither must we diminish the body weight too rapidly. The rate and amount of reduction in body weight to be aimed at depends on the obesity and age of the patient as well as on the strength of his heart, nerves, and muscles. Among the number of patients I

* See Table on next page.

have treated the following examples may be cited :—A man of thirty years of age, well built and weighing 130 kilos., lost 20 kilos in forty days, which represents a very rapid decrease. The following weights for eight consecutive weeks were recorded in the case of a very small woman of fifty-three years of age weighing 96·55 kilos :—(1) 94·8, (2) 94·5, (3) 93·1, (4) 89·7, (5) 89·6, (6) 87·7, (7) 86·1, (8) 84·7. This irregular curve differs from most others in that its greatest fall occurs at the end of the treatment, probably because of chronic double-sided rheumatoid arthritis in the knees, which I massaged for eight weeks, and which allowed the patient to take much longer walks during the latter part of the time than at first. I myself at the age of fifty-eight, my height being then 175 cm., and neither nerves nor heart being very strong, underwent the terrain and diet cure for seventy days with strict abstinence and a great deal of hard exercise up and down hill, in the course of which my weight decreased from 104·3 to 93·0 kilos. I did not consider a further reduction in weight advisable. In all the above-mentioned cases, especially in the first, I have found rapid diminu-

We may cite from a German medical calendar of average relative heights and weights the following table :—

	Males.		Females.	
	Centimetres.	Kilos.	Centimetres.	Kilos.
Newly born . . .	49·8	3·1	49·0	3·0
1 year. . .	70·0	9·0	69·0	8·6
2 years . . .	79·1	11·0	78·1	11·0
3 ,, . . .	86·4	12·5	85·4	12·4
4 ,, . . .	92·7	14·0	95·5	13·9
5 ,, . . .	98·7	15·9	97·4	15·3
6 ,, . . .	104·6	17·8	103·1	15·7
7 ,, . . .	110·4	19·7	108·7	17·8
8 ,, . . .	116·2	21·6	114·2	19·0
9 ,, . . .	121·8	23·5	119·6	21·0
10 ,, . . .	127·3	25·2	124·9	23·1
11 ,, . . .	132·5	27·0	130·1	25·5
12 ,, . .	137·5	29·0	135·2	29·0
13 ,, . . .	142·3	33·1	140·0	32·5
14 ,, . . .	146·9	37·1	144·6	36·3
15 ,, . . .	151·3	41·2	148·8	40·0
16 ,, . . .	155·4	45·4	152·1	43·5
17 ,, . . .	159·4	49·7	154·6	46·8
18 ,, . . .	163·0	53·9	156·3	49·8
19 ,, . . .	165·5	57·6	157·0	52·1
20 ,, . . .	167·0	59·5	157·4	53·2
25 ,, . . .	168·2	66·2	157·8	54·8
30 ,, . . .	168·6	66·1	158·0	55·3
40 ,, . . .	168·6	63·6	158·0	55·2
50 ,, . . .	168·6	63·5	158·0	55·2
60 ,, . . .	167·6	61·9	157·1	54·3
70 ,, . . .	166·0	59·5	155·6	51·5
80 ,, . . .	163·6	57·8	153·4	49·4
90 ,, . . .	161·0	57·8	151·0	49·3

tion of weight accompanied only by good results. It is impossible to give definite figures as to the decrease in weight to be aimed at, since, as above mentioned, it varies so much in individuals. It may be suggested as a general rule that people of middle age or of less than average strength should not continue the cure with decreased diet for more than two months, nor should their average decrease in weight exceed 10 per cent. of the normal body weight. Generally the greatest decrease is at the beginning of the treatment. *Care must be taken to prevent over-fatigue and loss of energy on the part of the patient, or inability to perform the mechanical routine of his daily life; he must not feel palpitations; his pulse must not be irregular or too slow; his sleep must not be worse; nor must there be any other neurasthenic symptoms, and treatment must immediately be stopped if any of these warning signs appear.*

If after two months the patient's weight is still excessive, it is advisable to lay down certain restrictions in diet for at least six months longer. This is difficult, depending as it does on the intelligence and will-power of the patient.

What effect has massage on the treatment of obesity?

Very little in comparison with the effect of systematic physical exercise. Muscle massage produces, by means of local muscle contractions, *some* effect on the increased breaking down of fat into CO_2 and water, but such effect is nothing to the effect of active muscle work. On the other hand, without doubt the movable pressure in massage has some effect on the absorption of fat *locally*. If a patient with diminished food and increased exercise becomes thin, his store of fat diminishes most in those parts which can be most easily reached by massage. Massage is commonly used in obesity for æsthetic purposes, and mostly by women who desire to get rid of a superabundance of tissue on the hips and abdomen. The same result can be obtained by decreased diet and the use of elastic bands which press on the parts affected.

With regard to dietetic treatment, all authorities are agreed that it must be effected by limitation of fat and carbohydrates.

The four best-known systems of diet for obesity are:—

	Protein (grams).	Fat (grams).	Carbohydrate (grams).
Voit	118	40	150
Harvey (= Banting)	172	8	81
Ebstein	102	85	47
Oertel { min.	156	22	71
Oertel { max.	170	43	114

In the section on the Diseases of the Heart I have already spoken of the danger of an excessive decrease in the supply of water. Even if there is some reason for limitation of fluid in failure of compensation of the heart, there is certainly no reason for it in uncomplicated cases of obesity. There is always a certain amount of risk in limitation of fluid. In cases of pure obesity it is quite unnecessary, as the desired result can be obtained without it, especially if the patient can walk.

No definite law can be stated as to the exact weight of the various foods to be supplied, nor is it necessary to do so. This may be decided according to what has been said above.

Any amount of protein may be taken, all kinds of lean meat, fish, and fowl; but patients must not take fat meat, cheese, milk, butter, and olive oil. The amount of bread must be regulated, *e.g.*, 100 grm. of Graham's bread * can be taken daily (= 40 grm. of starchy food), and in addition small quantities of vegetables, lettuce, spinach, French beans, tomatoes, cucumbers, asparagus, various kinds of cabbage, mushrooms, and other vegetables with a somewhat similar carbohydrate content. Sugar, sweets, chocolate, sweet preserved fruits, rice, macaroni, potatoes, haricot beans, peas, carrots, and other roots are strictly forbidden.

After a long experience I have come to the conclusion that in order to avoid digestive trouble, too rapid emaciation, etc., it is unwise, in uncomplicated cases of obesity, to diminish the daily portion of carbohydrates below 70 grm. Fatty food, on the contrary, may be reduced to a minimum.

In regard to drink, all kinds of malt drinks, wine, spirits, milk, cream should be given up as soon as possible. The patient may drink water and mineral waters, coffee and tea without sugar, and in some cases cocoa, but never chocolate.

With such a *régime*, together with two long walks a day, the decrease in weight desirable for the patient's health may be obtained.

* * * * *

Gout.

Our treatment of gout is based largely upon practical experience, since our knowledge of the disease itself is even more limited than in the case of other dystrophies. It has long been a matter of common knowledge that a sedentary life, combined with high feeding and the free use of alcohol, has a great influence in the production of gout, and we have always advised patients to take vigorous physical exercise, to avoid alcohol, and to live simply.

The reason why gouty patients are often ordered the terrain-cure and other cures is that in addition to gout they suffer from obesity and a weak heart. We allow them to have general massage once or twice a day if they wish, not only because of gout, but

* Graham's bread contains about 40 per cent., white bread about 51 per cent. starch. The former is better for constipation than the latter. Hard breads contain too much starchy material.

also because of rheumatism; for many gouty patients suffer from rheumatism, diabetes, and glycosuria.

No more need be said here of the mechano-therapy of gout and the treatment of gouty joints.

Concerning the diet for gout, I must here express my surprise at the frequency with which medical men regulate the diet in a perfectly unscientific manner, according to antiquated, and sometimes even superstitious, ideas. Their partiality for purely white, and fear of red meat for patients rests on no chemical or other rational basis whatever. It is impossible to explain the reason of their fear of cane sugar; disaccharin cane sugar is, like polysaccharin starch, changed in the organism to monosaccharin glucose. The avoidance of all foods that contain nuclein is better grounded, being based on our new knowledge of the important part played by the nucleins in the formation of uric acid and of the somewhat obscure effect of this upon gout. Many doctors still limit all three kinds of nutritive material, since Rubner and others pointed out our definite requirements. *It is impossible in the case of a middle-aged patient, accustomed to a generous diet, suddenly to put him on a very frugal diet, or to put him in a permanent condition of under-nutrition. The most important thing in the dietetic treatment of gout is to prevent over-feeding and to decrease the amount of protein taken to a very small portion daily. As far as possible all alcohol should be forbidden, and last, but not least, the amount of water taken daily must be regulated.*

For the treatment of arthritic joints I refer the reader to what has been said in preceding chapters.

* * * * *

Diabetes.

It has long been known that active exercise of the muscles decreases the amount of glycosuria in diabetes mellitus. This idea has been enlarged upon by Bouchardat (1841), by Külz (1874), and by von Mering, who noticed that when glycosuria is lessened by physical exercise the quantity of urine secreted is not increased.

Just as the clinical picture of diabetes mellitus and glycosuria presents endless variations, so does the therapeutic value of physical exercise vary for individual patients.

There are many individuals who never, or only occasionally, have an appreciable amount of sugar in the urine, but who frequently or constantly have some glycosuria after a rich meal; these individuals should take much active physical exercise, and are often very suitable cases for the terrain-cure, not only or chiefly because of the glycosuria, but rather because of gout, obesity, heart weakness, and other results of a sedentary life.

This is also the case with the mild cases of diabetes, i.e., those who

can take some carbohydrate without the appearance of glycosuria, or who at least are free from sugar when carbohydrates are excluded from the diet. In many cases where the diabetes is complicated by the presence of other ailments, especially obesity, the addition of physical exercise to the routine of daily life is beneficial. Although the patient has often a deceptive appearance of good health, the greatest care must be taken not to overtax his strength or diminish his weight too rapidly.

Advanced cases of diabetes, i.e., those cases in which, under any diet, sugar as well as acetone, diacetic acid, and often β-oxybutyric acid are present in the urine, are always critical cases and liable to end in coma, especially if β-oxybutyric acid is found in large quantities. *These are seldom suitable cases for gymnastics of any kind, and least of all for the terrain-cure*, since a short walk causing the slightest fatigue *may* induce a fatal termination.

It is obvious that muscle massage may have the same effect as physical exercise in decreasing the amount of glycosuria in diabetes. Finkler of Bonn and Brockhaus of Königsberg have shown this to be the case. Experiments were made in five cases of advanced, six cases of slight diabetes, and three cases of simple glycosuria. Massage consisting of muscle kneading over the whole body was given for periods of twenty minutes, at first once and later twice daily. The amount of carbohydrate taken by the patient was not determined, but was quite unlimited, and the patients were allowed to eat bread and potatoes, with plenty of fat and meat, as well as to drink ale. Some of the patients were up and taking vigorous physical exercise; others were in bed. In all cases a diminution in the secretion of sugar took place, the amount of urine diminishing, but the percentage of sugar remaining the same for a long time. In some cases the decrease was not noticeable; on the average, however, during three months' observation there was a decrease from 450 to 120 grm. per day!!? In the advanced cases the average for 100 days was 200 grm. per day, where before treatment it had been 730 grm.! In one case the sugar disappeared, in spite of mixed diet, after three months' treatment, and three months later reappeared to the amount of 5 grm. daily. The thirst disappeared, perspiration and body weight increased. One of the patients died from pneumonia, another from diabetic coma, during treatment.

Latterly I have made experiments in Carlsbad, where I treat a number of diabetics every year, in regard to the effects of massage on the excretion of sugar. Most patients who come to Carlsbad belong to the milder type of the disease, and many tolerate carbohydrates well. It is difficult, on account of the great variation in

tolerance, without any obvious reason, which is found in this disease, to carry out in a short time reliable investigations on this point. I have, however, come to the conclusion, in comparing the limit of assimilation in cases treated with and without massage, that general massage, carried out in long séances, does really by itself in some slight degree diminish glycosuria. Such a marked diminution as that noted by Finkler and Brockhaus I have never seen approached; and I do not consider it *possible* to produce this diminution by massage alone, even if the patient is massaged three or four hours daily. R. Seichten (1895) failed to find a decrease in the amount of sugar in the urine after massage. And I am certain that, in order to make adequate observation, massage must be given in thorough and prolonged séances. Quite apart from the diminution of glycosuria, the treatment often exercises a markedly beneficial effect in every respect on the patient. One of my patients, a young lady of some twenty years of age, had suffered from severe diabetes for two years (after a broken-off engagement), and, although on a strict diet (the diet was only given for a few days for the purpose of examination), a great amount of sugar was secreted, and her vitality was much lowered; her urine showed the well-known port wine reaction with ferric chloride. After a mineral water cure on the advice of another physician, she underwent treatment by general massage, during which she died of diabetic coma. This has happened to another of my patients, and also to one of Finkler's. It is hardly nesessary to point out that even massage cannot work miracles.

I do not know definitely what effect general massage in diabetes has upon the quantity of acetone, diacetic acid and β-oxybutyric acid in the blood. It has been several times my experience that patients suffering from advanced acidosis have died of coma immediately *after the cessation* of treatment by massage. It is probable that massage promotes the elimination of these toxins by the urine, especially of the dangerous product β-oxybutyric acid, so that the amount of it in the blood is lessened; also that muscle massage helps to complete the oxidation of these substances to carbonic acid and water.

The diet in diabetes is a complicated and much-discussed subject which I shall deal with very briefly. The diet of diabetic patients in my practice resembles that described above for obesity, but differs from it in that the fat in the food is never limited in diabetes, while carbohydrates are occasionally in the earlier stage absolutely excluded for a time. In advanced cases with acidosis (*i.e.*, the presence in the blood of diacetic and β-oxybutyric acid) the absolute exclusion of carbohydrates increases the danger of coma; and this method, chiefly advocated by Naunyn and

his school, must, in spite of his reputation, be condemned. At this stage I constantly allow a certain amount of carbohydrate; even in the early cases the "strict diet" should only be used periodically, and the daily amount of carbohydrates should not generally be less than 70 grm.

* * * * *

In Sweden *Rickets* has occasionally been treated by general massage. This has been more particularly the case in Stockholm, where the atonic condition of the intestines, so often associated with this disease, has led to the use of abdominal kneading, a treatment now very popular. *Next to abdominal kneading in value comes deep massage, especially effleurage, of the extremities.* Treatment lasts about a quarter of an hour, and is given with the patient undressed. Dr. P. Silfverskjöld * has given special attention to this treatment of rickets, and is quite satisfied with its results. He gives the maximum time for a complete return to health as four to six weeks. Massage may well be accompanied by passive gymnastic movements, and must of course be accompanied by dietetic and other treatment.

* * * * *

General massage, especially when combined with careful abdominal kneading, should be of great value in those cases of congenital disturbance of nutrition in infants in which growth is unsatisfactory in spite of good feeding; dyspeptic symptoms are often present, associated with irregular, fermenting and evil-smelling motions, and in severe cases *general atrophy* and death often result. Many reports in Stockholm show that such treatment may bring about improvement and health where otherwise the patient would probably die.

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What we have to say concerning massage in *arthritis deformans*, a disease which is now included among the anomalies of nutrition, will be found in the chapter on Joints.

* * * * *

Poisoning.

The relation of massage to the treatment of poisoning has for long been an open, but as yet an almost unexplored, field of discovery, which may be expected to be productive.

The physiological effect which we might expect to be useful is the mechanical stimulation of the nerves, and this has for long been used in the treatment of a collapsed or comatose condition, either in the form of tapôtement with the flat hand, flicking with

* "The Treatment of Rickets by Massage and Passive Movements." P. Silfverskjöld Eira, 1880.

towels, beating with a rod, or "flagellation," either on the palm of the hand, or the sole of the foot, or over the whole body. General massage, as already described in this book, is important in the treatment of the sensory and motor symptoms in cases of chronic poisoning. In cases of motor disturbances muscle massage is of great importance. The local effect of effleurage on the circulation is made use of for the prevention of gangrene. Lastly, the effect of massage on the heart and circulation must not be overlooked. Abdominal kneading is especially valuable in this respect, and should be included in the treatment of most cases.

From this it may be seen that massage in cases of poisoning where the symptoms are a complex arising from the cerebro-spinal and circulatory systems is usually "general" massage, varied according to the nature of the case.

The gymnastic exercises used in cases of poisoning are chiefly those which affect the heart and respiration.

The commonest forms of poisoning which one would expect to be benefited by massage and gymnastics are acute and chronic poisoning by the narcotics in common use, e.g., opium, morphia, cocaine, chloroform, chloral, sulphonal, trional, veronal, and alcohol, with other medicinal drugs such as aspirin, antipyrin, antifebrin, etc., acute poisoning by marsh gas, carbonic acid and coal gas, acute and chronic metal poisoning, poisoning by fungi, and snake bites.

Auto-intoxications are important and numerous, especially in diabetes (from β-oxybutyric acid) and in Bright's disease (from urea). Sudden death has been known to occur from uræmic coma on the cessation of general massage in advanced chronic inflammation of the kidneys, just as death from diabetic coma may, as I have already pointed out, occur under the same conditions.

According to Barett, Buller, Levis and Meyers, and others, in cases of acute *narcotic* poisoning, as in advanced cases of *alcoholism*, stimulation of the nerves by *flagellation* plays an important part (see Schrieber, "Massage"). In addition *general massage*, *respiratory movements*, electricity, cold douches, and other means available must not be forgotten.

General massage is also of value in cases of chronic poisoning. The most common of these are alcoholism, cocainism, chloralism, and morphinism, and it is perhaps particularly in the last (simple, or complicated by any other isomeric poison) that massage is of most value. In any case, however early, it is quite useless to treat these terrible diseases outside the special asylums where the patient is under full control. This can only be secured in a special institution where he is under constant and trustworthy supervision. In breaking off the habit the daily dose is first reduced by half, and

then diminished more slowly.* The patient frequently becomes so melancholic that every means is made use of to strengthen the heart and muscles and to improve the general condition. Especially during the time when he is confined to bed, which has its advantages, general massage, given by a firm reliable person, preferably two or three times a day, in my limited experience, does much good, and helps to some extent to shorten the terrible period of psychical and somatic weakness, always so trying to the patient and to his friends, a period inseparable from the breaking of the habit in whatever way it is done. The cure which these patients undergo is akin to the Weir-Mitchell treatment; the most important thing is the accustoming of the patient to gradually smaller doses and the firm exclusion of morphia from any outside source, which is not easy to secure.

In *chronic metal poisoning*, especially in chronic *lead and mercury poisoning*, gymnastics and especially massage are of the utmost importance.

In acute poisonings, which threaten paralysis of the respiratory and cardiac nerves, massage and gymnastics are always part of the treatment, and often the most important part.

This is particularly the case in poisoning, which is not uncommon, by *coal gas*, *carbon monoxide*, or *carbonic acid.*

All cases of threatened *suffocation* may be considered cases of carbonic acid poisoning.

In all these cases there are three special indications for treatment :—

(1) To clear the air passages from all which may impede the free entrance of fresh air (often from large pieces of food in the œsophagus pressing upon the trachea, from tight bands round the neck, most often from injurious gases or from water in the respiratory tract).

(2) By means of artificial respiration to restore normal exchange of gases in the lungs.

(3) By means of artificial respiration and other means to restore the activity of the heart.

The commonest death from asphyxiation is by *drowning*, which may therefore be taken as the type for treatment, but, of course,

* The method by which all supply of morphia is suddenly stopped is now out of date. It is certain that it works against itself by the threatened collapse in all cases where morphia has been used for any length of time or in large doses. The Erlenmeyer method, which stops all doses of morphia in eight to ten days, may occasionally in very light cases be carried out, but in the great majority of cases one is compelled to act more carefully and to diminish the daily dose very cautiously. If, after completely accustoming the patient to be without morphia (which should be after several weeks at least), one is not able to keep the patient for several months under one's own control or that of some reliable person, one may take for granted that a relapse will occur.

mutatis mutandis. I describe here the treatment of a person apparently drowned.

Marshall Hall's method consists, as is well known, in rolling the patient from side to side from the prone position in order to compress and expand the sides of the chest alternately.

In Howard's method the operator places himself astride the patient's body, the patient lying on his back with a cushion under the lumbar region and the lower part of the thorax; the operator then compresses the lower part of the chest at the rate of sixteen times per minute and allows it to expand by its own elasticity.

According to Silvester's method, the patient is placed on his back with the upper part of the trunk raised. Artificial respiration is given in the following manner:—The operator, placed behind the patient, grasps the patient's elbows with both hands, and at the rate of about sixteen times per minute carries the arms up to the side of the patient's head, and then lowers them, pressing them against the lower part of the thorax. In this way expiration and inspiration are produced alternately.

In Sweden the excellent apparatus invented by the Swedish physician, Dr. K. A. Fries, for producing artificial respiration is coming into use. This apparatus, by means of levers, produces ventilation of the lungs up to a capacity of $2\frac{1}{2}$ litres.

Whichever method is employed, the work should be continued until the patient himself takes fairly deep breaths, which may be brought about a long time, perhaps some hours, after he has been without any sign of life.

The patient's tongue must be drawn forward throughout. As he begins to recover, tea, coffee, ether, etc., should be given.

I consider Dr. Fries' method the best of all. For my part I consider that one should always fulfil the first indication: to clear the air passages of all extraneous matter such as water, etc. To do this the patient is held for a short time in the prone position with the pelvis considerably higher than the head (with the help of several people), and then rhythmic pressure is applied to the sides of the thorax. I also consider that in Silvester's method, which is still the most commonly used, strong effleurage applied by two people over the lower extremities at the same time does much to cause a return of circulation.

In *fungus* poisoning massage and respiratory movements are a rational adjunct to other treatment in the narcotic stage. In cases of acute or chronic *ergotism* strong effleurage might well be given to cause a more rapid circulation, and therefore prevent or limit gangrene, while acting beneficially on other symptoms. There are to my knowledge no reports on this subject.

This is probably also the case in regard to the effects of general massage after *snake bite*, where the common symptoms of collapse might well be counteracted. This treatment, however, is very little used, whether in Europe, where we rarely meet with the results of snake bite, or in other parts of the world where the most dangerous forms of bite are those of crotalus, trigonocephalus, naja, etc., which often cause death. The local symptoms consist of œdematous infiltrations, sometimes followed by gangrene, and might well be treated by effleurage ; but it must be remembered that this treatment would help to spread the poison unless thorough local treatment of the wound had first been carried out by ligature, incision, cauterisation, etc. Here, as in all other cases, mechano-therapy must not be the only means thought of ; it should be used in conjunction with other treatment, especially alcohol, about which opinions are divided. Some medical men use it only as a preventive of collapse and heart paralysis, and in moderate doses ; others use it as a specific antidote, and in very large doses. The last method is in common use in North America, and has proved most efficacious in saving lives which would otherwise have been lost from dangerous bites from snakes, the cobra, or the moccasin snake. Should I have to treat such a case, my method of procedure would be as follows :—First, local and energetic treatment by ligature, cauterisation, or sucking away the poison, followed by injections of permanganate of potash, or serum treatment, much spoken of in these days, but a remedy of which I know little. After this large doses of whisky or brandy should be given, together with respiratory movements for hours or until the symptoms of poisoning disappear, alternating with general massage, preferably given by several people at once, with effleurage of the extremities and strong abdominal kneading.

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